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# A Manual for Community and Fiscal Impact Modeling Systems

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## Recommended Citation

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# **A Manual for Community and Fiscal Impact Modeling Systems**

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## **Practical Techniques for Building and Applying Community Level Models**

Prepared by

David Swenson and Liesl Eathington

**Department of Economics  
Iowa State University**

## A MANUAL FOR COMMUNITY AND FISCAL IMPACT MODELING SYSTEMS

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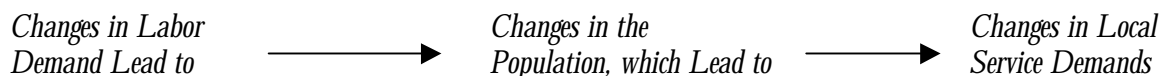
# A Manual for Community and Fiscal Impact Modeling Systems

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**Department of Economics**  
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## Introduction

Over the past few years several states have developed community and fiscal impact modeling systems. Beginning with the VIP model in Virginia, which was developed by Tom Johnson<sup>1</sup>, and followed by Idaho, Iowa, and Missouri<sup>2</sup>, several mid-western states established or enhanced their capacities to conduct community labor force and fiscal impact analysis. To date, models also have been developed or finalized in Kansas, Minnesota, Nevada, Nebraska, Pennsylvania, Wisconsin, and Kentucky. Models are under construction in Texas, Ohio, and Vermont. A model will soon be developed for Oregon.

The basic conceptual foundation for these models is straightforward. Exogenous shocks to local employment induce changes in local labor supply and changes in residential preferences regionally. The strength of these preferences and the probability of mobility (either as migration or commuting) are a function of the size of employment locally, the size of the labor force locally, the size of employment and the labor force regionally, and general community attributes. When communities experience labor force and population growth, demands for community services increase as do the marginal resources necessary to pay for those services, as illustrated in this simple schematic.



This compilation is designed to introduce the reader to community impact modeling systems. It draws upon our experiences at Iowa State University to develop and improve our modeling systems and upon our technical assistance experiences with several states interested in

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1. See, for example, the "User's Manual for the VIP Fiscal Impact Model," and the "Virginia Impact Projection (VIP) Manual Operations Manual." Department of Agricultural Economics, VPI, 1986. This early work established the conceptual foundations and the application of micro-computer capacity to community modeling.

2. The Iowa model is called the Iowa Economic/Fiscal Impact Modeling System and is comprised of a set of linked local government models that estimate city, school, and county government impacts attributable to changes in local employment demand. The Missouri model is called SHOW ME. It is a county government model, and it is used primarily to test policy change and economic growth scenarios for counties.

producing home-grown versions of the models. We also acknowledge our widespread dependence on the efforts of others in this area.

Each state that develops this modeling capacity has its own set of issues and particular intended uses – they invariably introduce innovations that are relevant and useful to the rest of us. In western states, for example, issues might center around federal fund and state fund transfers and just a few basic local government service needs. In other states, the fiscal elements may be discounted in favor of identifying expected changes in regional consumption and other local economic effects. Some states have good indigenous data to use for fiscal analysis: others, like Iowa, are highly dependent on data collected during the quinquennial census of local governments. Some have geographic barriers that create problems in the gravity components of the estimation model. Other states, like Iowa (and Nebraska), are the stereotypical “featureless planes” where calculating inter-regional labor relationships is much easier and statistically pleasing as compared to Appalachian or Rocky Mountain states. Finally, some western states have relatively few counties: estimations suffer from an absence of observations. No matter the limitations or the opportunities, however, there are several conceptual and procedural steps that must be taken to build the community impact model. We can break these steps into at least six distinct parts.

### **Part 1. The Conceptual Model**

Regional scientists are acutely aware of the hunger for good information among state and local decision makers. Analysts are also acutely aware that decisions at the federal level are often made without regard to the potential state or community impacts that might ensue. Changes in fiscal and structural federalism have revised the relationships of the federal government with the states and the states with local governments. As the 1990s end it is evident to any student of government finance and government policy that the overall structure, capacity, and missions of governments are much different than they were in the 1980s, which in turn were much different than much of the previous decade.

Not only are there differences in fiscal federalism, there are also profound differences in the structure and incentives of the nation’s labor force. The nation currently is at full or near-full employment. Large fractions of the nation’s labor supply are working. Where workers work and where workers live are important issues for community and regional land use, transportation, and other public services planning. Workers remain mobile. Suburbanization continues. The dominant transportation investment in the nation are highway systems. In short, where people live and where people work are dynamic systems that must be accounted before we can adequately anticipate labor force, economic, and fiscal changes in light of industrial growth or decline and changes in employment in an area.

### **Part 2. Collecting the Data**

After finally swallowing the conceptual model, many prospective analysts choke on the apparent difficulty of acquiring the data needed for analysis. Labor force compilations need to

be made for the counties using data from the 1990 census (now quite dated but still useful, nonetheless). Incommuters and outcommuters need to be estimated. Counts need to be compiled that estimate the number of workers in a county that both live and work in a county. Not only do we need to know the number of incommuters and outcommuters, we also need to know where they commute from. Most of the data are readily available from the U.S. Census Bureau web site or the BEA's Regional Economic Information Service CD-ROM.

Because these models are decision models for use primarily by local government officials, it is important to use reliable local government financial data. Many states do a good job compiling local government financial information; others, like Iowa, do not. The federal government compiles quinquennial censuses of all government finances. These data sets are massive. We provide information and assistance to states in accessing these data, including programs to read the raw data and write it for entry into other systems, already extracted local government revenue and expenditure data that are compiled as SAS system files, and spreadsheets of common revenue and expenditure items for all governments in a state.

The data acquisition becomes slightly more complicated if the analysts decide to build a municipality-based rather than or along with a county-based model. Government statistics are primarily collected at the county level – subcounty data compilations are rare and their quality is suspect. Still, we can build reasonably good city and county models. In Iowa we have built a county government model (which subsumes school district impacts) and a city government impact model. The models are run simultaneously to apportion impacts to the appropriate government and the appropriate territory; i.e., impacts accruing within a municipality and those outside of the municipality. This all assumes, of course, that spatial considerations are quite important in these models. Persons interested in compiling city-based models are encouraged to contact the authors for additional procedures.

Finally, labor and fiscal variables are not enough. Physical, economic, and social characteristics of the communities or counties that we are modeling are important for isolating variability among our communities. Most of those data are also available from the 1990 census, and some has been compiled in useful form in a variety of ftp sites (like [www.ciesin.org](http://www.ciesin.org) ). Other data may be obtained from County Business Patterns or from state departments of revenue who maintain information on, for example, state sales tax collections and firms subject to those taxes.

### **Part 3. Compiling Variables and Selecting the Level of Analysis**

A larger hurdle to clear involves the initial processing of the labor force and of the fiscal data. We have tried to make it a low hurdle instead of a high one. When we first compiled our model in Iowa we were required to read our data from then recently released census tapes. Now the labor force and the incommuter and outcommuter information are easily accessed via the internet or from commonly available CD-ROMs from the BEA. Although getting the data are now easy, there are still steps to processing the data that require a little effort.

The labor force component is gravity based: that means that the size of local employment and of the local labor force must be considered in light of external employment and the external labor force. It is necessary, then, to compile counts of external employment and the external labor force, and it is necessary to localize that employment spatially. To do so requires finding appropriate latitudes and longitudes relative to your counties of study and processing the data to arrive at appropriate distance calculations. For some of the more picky among us, care might also be taken at this point to arrive at a distance-decay function that best approximates a region's labor to employment characteristics. For the rest of us, however, distance squared seems to do the trick.

There is an additional important element of this section. It deals with the spatial and institutional relationships that are evident in your state of study. Simply put, local government service territories often overlap but do not align – school districts do not align with municipalities or with counties; drainage districts or some other form of special governmental district may cross county or even state lines. There may also be quite distinct differences in allowable local government functions by kind of government, by classes of communities and counties. We must also add to this the probability of acquiring relevant data on all of our local government service territories. Some of these pitfalls are discussed in this section.

#### **Part 4. Estimating and Evaluating the Equations**

Once all of the data have been organized a system of equations needs to be set up that is consistent with the conceptual model (Part 1). The proper specification of the variables and the proper form of estimation are important considerations. Very strong justification exists for using 3-stage least squares when estimating the labor force and the fiscal impact variables (as described in the Johnson, et al, article). Accordingly, care must be taken to specify identities, instruments, and the endogenous variables properly. It is also important to realize that as the number of equations in the system expands, the more unstable the model may become.

Many analysts might find it useful to compile their original model prototype using 3-stage least squares for the labor force equations and OLS for the fiscal or economic indicators. Over time they can revise and re-specify their model consistent with theory. An OLS-based model is far superior, of course, to no model and, in our experience, only slightly less descriptive than a fully estimated 3-stage least squares model. This is especially true because the advantages to 3-stage least squares seem to accrue mostly to the tails of the distribution—accuracy is probably not significantly improved for the mean county or community.

This section discusses the procedures of model specification. In addition, significant attention is paid to common problems in construction, specification, and evaluation of the model and its equations.



## **Part 5. Creating the Impact Assessment Spreadsheet or Database**

The pre-processed data and the coefficients generated need to be put into some system so that simulations can be made. Most models to date have used a Lotus 123 or an Microsoft Excel spreadsheet format. The models can also be compiled using traditional statistical programs such as SAS or SPSS. We recently have also created an interactive model using Microsoft Access (this was to facilitate translation into HTML for the posting of a web-based model).

The whole point of this section is to introduce the model builder to different approaches to developing a spreadsheet (or some other means of conveyance) for calculating the outcomes and displaying the results. Our original model was very transparent and consisted of three linked spreadsheets: one to report the results in a relatively pleasing format, one to compile the county level impacts, and another to compile the community level impacts. Our newest model is significantly revised, more interactive, way more pleasing to look at, and divided into functional segments. The output does not change regardless of the form, although the ease of use does.

## **Part 6. Using the Model**

While most of us have a general idea of what we want to do with our community impact model, the simple fact is that each state applies their models somewhat differently and towards different ends. Here in Iowa, the model is almost exclusively used as an impact model that is linked to the results of an input-output analysis of local employment change. In addition, the typical client is the community not the county, since most economic development gains and losses accrue and are measured at the municipal level. The Wisconsin model appears to more readily describe expected changes in the commercial environment instead of the fiscal environment. The Missouri Show Me model is a county based system designed to be used to test different growth and change scenarios for participating counties. Western states models appear to be more sensitive to issues associated with resource extraction and with physical infrastructure costs. In this section of the report we compile a set of impact analysis descriptions and approaches.

# **PART 1. THE CONCEPTUAL MODEL**

## **Overview of Part One**

### **Objectives**

- ❑ Understand the theoretical foundation for a network of models that are related by design, yet community-specific by detail.
- ❑ Determine the type of decision support that will be accepted by and useful to community officials.

### **Assumptions**

- ❑ Employment change drives labor force and economic change at the local level.
- ❑ Relationships between employment, labor force, social, and fiscal variables can be represented by systems of linear equations.

### **Requirements**

- ❑ Conceptual foundations from the social sciences and regional science.
- ❑ Familiarity with state/community characteristics and local issues.

## **PART ONE**

### **The Community Policy Analysis System (COMPAS)\***

**Thomas G. Johnson**

**James K. Scott**

**Jian Ma<sup>1</sup>**

**February 1, 1997**

#### **Introduction**

Devolution of authority and responsibility from the Federal Government to state and local governments is, and will continue to be, one of the most dominant public policy issue for communities in the last half decade of this century. Block grants, deregulation, welfare reform, health care reform, education reform, agricultural policy reform, various state waivers, and other terms fill the national policy dialogue and all are symptomatic of devolution.

To communities, especially rural communities, devolution spells the end of many of the safety nets that protected local governments, school districts, and other public entities from some economic and social hardships. At the same time devolution enhances opportunities for local leadership and increases the returns to aggressive and innovative public decision making. In this environment, the value of economic and social information, accurate projections, and analyses of policy alternatives is particularly great. This in turn is creating an opportunity for those involved in the decision support sciences.

The Community Policy Analysis System (COMPAS) is a response to this opportunity. It tries to address the information needs of policy makers at the Federal, state and local levels. At the Federal level, there is a growing need for a better understanding of the local consequences of federal policy, especially policy that devolves responsibility to local governments. Similarly, state governments require information on the consequences of their policies on local governments as both state and local responsibilities change.

The need, under these emerging circumstances, for better decision support at the local level is obvious. The diversity of conditions in rural communities means that generic, or overly-aggregated decision support tools probably mask more than they reveal. Broad generalizations about policy impacts are usually uninformative at best, misleading at worst. It is clear, for example, that to conclude that trade liberalization will lead to overall increases in income and employment is an important aggregate projection, but it tells us little about the changes that will be experienced by individual communities or what their optimum responses to these changes might be.

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\* Reprinted with the permission of the authors. This paper has been distributed widely via conferences and presentations, and it is also available on the Rural Policy Research Institute web site at [www.rurpri.org](http://www.rurpri.org).

In response to this need for community level information to support Federal, state and local policy making, an ambitious and innovative approach is called for. This paper describes a proposed and on-going effort to provide some of this information. What is proposed is a national system of community level models based on a standardized accounting system and system of economic and social indicators but a decentralized, bottoms-up approach to model development. The proposal takes into account the data realities at the community level, and it attempts to incorporate the current conceptual foundations from the social sciences and regional science. It is evolutionary in that it will be designed to be flexible and continually improved upon, and it recognizes and tries to accommodate the structural, institutional, and constitutional differences among states and communities.

The model discussed below is based primarily on the authors' experiences with the Virginia Impact Project (VIP) model and Missouri's Show Me Model, which have evolved over the last decade. These models are just the most recent chapter in a long tradition of community modeling by rural development researchers (see Halstead, Leistritz, and Johnson for a history of just a few of these models). The novel aspect of this project is the attempt to create models for communities throughout the nation.

### **The Elements of a Community Policy Analysis System**

There are a staggering number of considerations involved in modeling a community for policy analysis. The following assumptions are based on conceptual logic and ours and many other empirical studies of communities. Each is reflected in the proposed community modeling framework.

1. While economic and social relationships are only indirectly influenced by geopolitical boundaries, policy provisions, public services, taxing authority, and data, are heavily influenced. Therefore, county, municipal, and other local government public service boundaries should be at the basis of any policy model.
2. Communities within states share common constitutional limitations and responsibilities, and they have developed comparable institutions.
3. Communities with similar economic bases have similar economic structures. Because of the importance of climactic, geographic, social and political influences, economic bases are frequently quite homogeneous across geographic regions.
4. Communities of similar size and with similar geographic relationships to nearby larger and smaller communities perform similar central place roles and are likely to exhibit similar responses to economic (and policy) stimuli.
5. The fundamental engine for economic growth, decline, and change at the local level is employment. Community impacts are affected through the labor market, which allocates jobs between the currently unemployed, residents of nearby communities

(incommuters), current residents who work outside the community (outcommuters), and new entrants to the local labor market.

6. Changes in employment, unemployment, commuting, labor force, population, school enrollment, and income lead to changes in housing needs, property tax bases, public service demands, and state and federal transfers to households and local governments.

These principles guided the estimation and development of the Virginia Impact Projection (VIP) model and the Show Me model for Missouri communities. They are also the guiding principles for models developed in Iowa, Idaho, and the host of other states who have either built or are building these models. These models are systems of cross-sectional, econometrically estimated equations estimated for rural communities and cities in the respective states.

Experience with the estimation of these models indicates that with careful selection of variables and functional form, stable coefficients can be estimated for communities with a wide variety of sizes and economic bases. Basic institutional differences cannot be captured with a single set of parameter estimates, however. Furthermore, attempts to apply the model to other states have underscored the importance of differences in the structure of public service provision. Therefore, only states with very similar local government structures will be candidates for grouping together.

### **How These Models Work**

While many different model structures could generate comparable policy analyses, it is proposed that the COMPAS models share a basic structure.

The COMPAS models will be based on the assumptions above as well as others about the way in which rural and small city economies work, about the way in which local governments make decisions, and about the conditions under which local public services are provided. In the following pages, the first and most simple of the COMPAS models will be described.

### **Labor Market Equations**

The labor market concept plays a central role in the COMPAS models. The models are built on the assumption that economic growth is caused largely by exogenous increases in employment. This is not to say that employment at the community level is not responsive to local conditions but rather, that these responses will be dealt with as direct changes or shocks to be introduced to the models. In this simple model, demand can be viewed as perfectly inelastic at the exogenous level of employment. Total labor supply is perfectly elastic at the prevailing regional or national wage level (adjusted for local cost of living, amenities, etc.). Labor supply is composed of two components: locally employed residents and locally employed non-residents or incommuters. Locally employed residents equals the resident labor force less unemployed and outcommuters. These relationships are shown in Figure 1.

**Figure 1. The Conceptual Labor Market**



Incommuters and outcommuters are separated here, rather than combined into net commuters, because they persist in the long-term due to differences in preferences for public services, spatial amenities, occupational characteristics of households, and the existence of sub-markets for different labor skills. Labor force and incommuters are positive components of supply and outcommuting is a negative component. Unemployment is a residual negative component of supply. Eliminating wages from the component supply curves by substituting the inverse demand curve, as amended, derives the expressions. This introduces employment (demand) to the supply components. More formally, the model is developed as follows:

$$1) \quad X_D = X_s,$$

equates demand and supply (local employment and employed labor force from all locations). The demand curve is

$$2) \quad X_D = f(w),$$

(where  $w$  is the wage rate) which when inverted becomes

$$3) \quad w = g(X_D).$$

Decomposing labor supply into its components gives

$$4) \quad X_S = X_{LF} - X_U - X_O + X_I$$

Each component of supply is a function of employment and a vector of supply shifters,

$$5) \quad X_{LF} = f_L(w, Z_{LF}) = f_L(g(X_D), Z_{LF}),$$

$$6) \quad X_O = f_O(w, Z_O) = f_O(g(X_D), Z_O), \text{ and}$$

$$7) \quad X_I = f_I(w, Z_I) = f_I(g(X_D), Z_I)$$

where,  $X_D$  is labor demand (local employment),  $X_S$  is labor supply, made up of its components,  $X_{LF}$  (resident labor force),  $X_O$  (outcommuters),  $X_I$  (incommuters), and  $X_U$  (unemployed),  $w$  is the wage rate, and the  $Z$ s are supply shifters for the various components of supply.

Given the discussion and the conceptual model above, equations 4 through 7 can be expressed as follows in equations 8 through 11.<sup>2</sup>

$$8) \quad \textbf{Unemployed = Labor Force + Incommuters - Employment - Outcommuters}$$

All three components of labor supply will be determined primarily by employment in the location in question. In addition, they will depend on relative housing conditions, costs of living, quality of public services, tax levels, the mix of jobs, and similar variables in the location of employment versus alternative locations. A very important variable in the supply component is the area of the data unit. Smaller units will include fewer resident laborers and define more as outcommuters and incommuters because the small size dictates higher probabilities of crossing the boundaries of the unit. Larger units will incorporate more destinations and residences of resident workers and, usually, define more workers as locally employed resulting in fewer outcommuters and incommuters. Overall levels of commuting will depend on the distance between place of residence and place of work.

$$9) \quad \textbf{Labor force = f(employment, housing conditions, cost of living, public services, taxes, industry mix, area).}$$

$$10) \quad \textbf{Outcommuting = f(employment, external employment, external labor force, housing conditions, cost of living, public services, taxes, industry mix, area, distance to jobs).}$$

11) ***Incommuting = f(employment, external employment, external labor force, housing conditions, cost of living, public services, taxes, industry mix, area, distance to residence).***

Population is hypothesized to be a function of labor force and variables that affect the labor force participation rate and the dependency ratio.

12) ***Population = f(labor force, dependency rate)***

where the dependency rate is the ratio of the non-working population to the working population.

### **Fiscal Impact Equations**

Changes in the local government tax bases and changes in the need for locally supplied services usually accompany changes in employment. New employers, employees, and population require expenditures for services and investments in infrastructure.

The demands for public services by residents depend on such factors as income, wealth, unemployment, age, and education. As growth changes these characteristics, the demand per resident will rise or fall. As a community grows, the average cost of producing public services often decreases until all economies of size are captured and then increases when inefficiencies creep into the process. Together, the changing demand and efficiency determinants mean that each economic change will have a unique effect on needed expenditures.

It is assumed that local governments consider the demands of their constituents and then provide the desired level of services at the lowest possible cost. When tax bases and the demand for expenditures are known, local governments are assumed to adjust tax rate to balance their budget.

Following Hirsch (1970 and 1977); Beaton; Stinson; and Stinson and Lubov; unit cost of public services are hypothesized to be a function of the level, and quality of services, important local characteristics (input factors and demand factors), input prices, and the rate of population growth. Furthermore, theory suggests that public services may be variably subject to increasing or decreasing returns to size. Based on these theoretical relationships local government service expenditures per capita were hypothesized to be determined as follows:

13) ***Expenditures = f(quality, quantity, input conditions, demand conditions).***

For each type of expenditures (public works, police protection, administration, parks and recreation, welfare, education, fire protection, etc.) the independent variables are defined differently. For education, enrollment is the quantity variable, teachers per thousand students is a quality variable, federal aid and change in enrollment are input conditions, and income, real property, and employment are demand conditions. For police protection, population is the quantity variable, solved crimes is the quality variable, percent population in towns,



incommuters, and miles to the nearest metropolitan area are input conditions, and income and personal property are demand conditions.

Many non-local revenues (from state and federal agencies) are at least partially formula driven. Even when this is not the case, certain local characteristics may indicate the expected level of these revenues. In addition, non-local revenues are frequently an inverse function of the locality's ability to pay and a direct function of [its degree of political influence](#). Ability to pay is usually related to per capita income, personal property per capita, and real property per capita.

$$14) \quad \textbf{Non-local aid} = f(\textbf{expenditures, income, personal property, real property}).$$

Another important source of local revenues are sales tax revenues. The level of retail sales is primarily a function of income. This relationship is expected to change with the size of the locality since larger localities are usually higher order service centers. The number of incommuters is also hypothesized to influence sales because they increase the daytime population of the community. Sales tax revenues are hypothesized, therefore, to be:

$$15) \quad \textbf{Sales tax Revenues} = f(\textbf{income, employment, incommuters}).$$

Other local revenues, other than property taxes, include licenses, fees, fines, forfeitures, and special assessments. These revenues are hypothesized to be related to the level of commercial activity (retail activity) in the community and the income level. Thus:

$$16) \quad \textbf{Other Tax Revenues} = f(\textbf{Sales tax revenues, income}).$$

Real property includes both residential and business property and, therefore, will be influenced by the level of personal income as well as the size of the economic base. Both personal and real property are hypothesized to be positively related to the number of outcommuters since these families represent a source of wealth that is not supported by the local economic base.

$$17) \quad \textbf{Real Property} = f(\textbf{income, employment, outcommuters}),$$

$$18) \quad \textbf{Personal Property} = f(\textbf{income, outcommuters}).$$

There are a number of ways to close this type of model. In the case of the VIP model it is assumed that local government expenditures are determined first, and real and personal property tax rates are set to cover those expenditures not met by non-local aid and sales tax revenues and other tax revenues. This implicitly assumes that budgets are balanced each year. An alternate assumption (the one used in the Show Me) is that the tax rate remains constant and that economic changes lead to fiscal deficits or surpluses. In the Iowa model, local government revenue and expenditures are constrained to balance and are, therefore, specified accordingly – differences are allocated into plus or minus ending balances, which would hypothetically carry forward into the next budgeting year.

## **Experiences with These Models**

To date, VIP and Show Me models have been developed for forty to fifty communities. A related model developed at Iowa State University has been employed for several dozen Iowa communities. Local advisory committees are usually appointed to review the baseline projections, help form the scenarios, review the model's projection, and to help interpret the results. The models have been used for a variety of purposes including analyses of annexations, jurisdictional mergers, new industries, existing industries, industry closures, university research parks, shopping centers, residential developments, location of industrial sites and, and general development strategies. They have been used to assess the desirability and efficacy of industrial and housing tax abatement strategies and to test different industrial growth funding scenarios. They have also been used for goal planning for several communities. Goal planning with the models is achieved by estimating the conditions necessary to bring about a desired set of terminal conditions.

The models have generally been popular with local and state governments. Policy makers are generally and initially somewhat skeptical until they come to appreciate the information generated and become more confident in the projections. Repeat users of the model's projections especially like the comparability of the results from case to case, and across communities.

## **Conclusions**

Glenn Nelson offers a six-point test for relevance of policy analysis. These points are that the analysts must:

- 1) take a prospective orientation -- a forward looking view of likely events;
- 2) accomplish effective problem definition -- that is that they identify important future policy issues and questions;
- 3) have access to a network of experts;
- 4) estimate direct and indirect effects of issues and policy alternatives;
- 5) have access to databases which match their needs; and
- 6) be an active participant in the delivery of policy relevant information.

The community modeling framework described here makes it much easier for policy analysts to pass this test.

The models will not help analysts anticipate issues, but they will certainly give them a prospective orientation regarding the consequences. The models will (and already have) provided bases for a network of experts. The models are explicitly designed to predict direct and indirect effects of issues and policies. They will use, create, and ensure relatively uniform data bases for policy analysis. And experience demonstrates that these models open the door for analysts to engage meaningfully in the policy making process.

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<sup>1</sup> Frank Miller Professor of Agricultural Economics, Research Assistant Professor, and Research Associate University of Missouri. This paper was prepared for presentation at the 1997 meeting of the Southern Extension and Research Activities - Information Exchange Group (SERA-IEG) 53 meetings in Birmingham Alabama, February 1 - 2, 1997.

<sup>2</sup> If one's estimate of employment is defined as jobs, rather than the number of persons employed, then it will include second jobs. In this case, employment as defined here equals jobs less second jobs. Alternatively, one must augment the supply of labor by the number of individuals holding second and third jobs.

## **PART 2. COLLECTING THE DATA**

### **Overview of Part Two**

#### **Objectives**

- ❑ Find data to describe the size and commuting characteristics of the local labor force.
- ❑ Collect other data from reliable sources to describe various social, fiscal, economic, and physical attributes of communities in the model.

#### **Assumptions**

- ❑ Data collected by decennial or quinquennial census still adequately describe community characteristics even after several years have lapsed.
- ❑ Data are collected in a consistent manner across time and localities.

#### **Requirements**

- ❑ Access to electronic data sources such as CD-ROM and the Internet.
- ❑ Spreadsheet and other data processing skills.

## PART TWO

### Collecting the Data

Analysts soon recognize that the data requirements for developing community impact models are large and diverse. This short section describes the primary sources of data used in community impact model development. The segments isolate data needs related to estimating the labor force component and the fiscal component, including social and economic attributes.

#### **Problem 1: Working With the Labor Force Data**

Complete and standardized estimates of county and community labor force characteristics are at their best during the decennial counts of housing and population by the U.S. Bureau of the Census. Recalling the discussion in Part 1 on the construction of the primary equations, we need to know several elements of an area's labor force: employment locally, incommuting, outcommuting, and unemployment. Good inter-county estimates of incommuting and outcommuting are only done during the census years\*; accordingly, we are very dependent on the 1990 census to describe the relationships of our counties with the regional economy.

Borrowing from the conceptual discussion in Part 1, the primary equations in the labor force component in the model can be written elementally as

1. Labor Force  $\div$  (Place of Work Employment, Incommuters, Outcommuters, Unemployed) or  
Unemployed  $\div$  (Labor Force, Place of Work Employment, Incommuters, Outcommuters)
2. Incommuters =  $f_i$ (Employment, Contiguous Employment, Contiguous Labor Force)
3. Outcommuters =  $f_o$ (Employment, Contiguous Employment, Contiguous Labor Force)
4. Population =  $f_p$ (Labor Force, Total Participation Rate)
5. Enrollment =  $f_e$ (Labor Force, Male Participation Rate, Female Participation Rate)

#### **Commuting Data**

Getting the incommuting and outcommuting numbers along with the place of work employment estimates requires us to depend on data collected for the 1990 census – there simply are no newer numbers. When the 2000 census is available, we will revise our models accordingly. The easiest way to get the needed numbers on incommuters and outcommuters at the county level is to use the journey to work data (JTW) that are contained in the Regional Economic Information Service (REIS) CD-ROM that comes out annually from the U.S. Bureau

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\* Inter-county commuting data for 1990 are not comparable with previous censuses. In earlier censuses respondents were essentially given an “unknown” option on where they worked; the 1990 census eliminated that choice. Substantial missing data in earlier years therefore make inter-decade comparisons meaningless.

of Economic Analysis (BEA). The data that are contained on the CD-ROM are the same data that are available from the Bureau of the Census data tape Summary Tape File S-5 (STF-S5), “Number of Workers by County of Residence by County of Work.” The BEA uses these data (along with estimates of employment change) to determine net earnings exports for the counties annually.

**Figure 2. The BEA Journey to Work (JTW) Database Viewer**

POR	RESCTY	RST	POW	WORKCTY	WST	WORKERS60	WORKERS70	WORKERS80
56001	ALBANY	WY	08031	DENVER	CO	0	32	
56001	ALBANY	WY	08057	JACKSON	CO	12	0	
56001	ALBANY	WY	08069	LARIMER	CO	13	13	
56001	ALBANY	WY	08123	WELD	CO	4	0	1
56001	ALBANY	WY	56001	ALBANY	WY	7,129	8,634	12,12
56001	ALBANY	WY	56007	CARBON	WY	23	56	23
56001	ALBANY	WY	56009	CONVERSE	WY	8	0	2
56001	ALBANY	WY	56015	GOSHEN	WY	5	7	
56001	ALBANY	WY	56021	LARAMIE	WY	125	368	12
56001	ALBANY	WY	56025	NATRONA	WY	23	41	2
56001	ALBANY	WY	56031	PLATTE	WY	8	0	5
56001	ALBANY	WY	56037	SWEETWATER	WY	0	0	
56001	ALBANY	WY	99998	ELSEWHERE	XX	58	126	14
56001	ALBANY	WY	99999	NOT	XX	267	725	
56003	BIG HORN	WY	30111	YELLOWSTONE	MT	16	34	
56003	BIG HORN	WY	56003	BIG HORN	WY	3,628	3,113	4,37
56003	BIG HORN	WY	56017	HOT SPRINGS	WY	13	0	
56003	BIG HORN	WY	56025	NATRONA	WY	12	0	
56003	BIG HORN	WY	56029	PARK	WY	118	92	21
56003	BIG HORN	WY	56033	SHERIDAN	WY	0	14	
56003	BIG HORN	WY	56043	WASHAKIE	WY	43	60	10
56003	BIG HORN	WY	99998	ELSEWHERE	XX	50	95	13
56003	BIG HORN	WY	99999	NOT	XX	218	279	
56005	CAMPBELL	WY	56005	CAMPBELL	WY	2,120	4,353	11,78
56005	CAMPBELL	WY	56009	CONVERSE	WY	0	0	7
56005	CAMPBELL	WY	56011	CROOK	WY	46	21	7
56005	CAMPBELL	WY	56019	JOHNSON	WY	0	6	2
56005	CAMPBELL	WY	56025	NATRONA	WY	0	20	8
56005	CAMPBELL	WY	56029	PARK	WY	0	0	
56005	CAMPBELL	WY	56033	SHERIDAN	WY	0	0	
56005	CAMPBELL	WY	56045	WESTON	WY	0	0	5

This data set lists counts of workers by place of residence (POR) and place of work (POW). The database viewer comes with a query option that allows us to limit and compile the data by POR or POW. Each data set can be exported into Paradox or Access or some other suitable data set for additional processing. The same compilations can be made from STF-S5 using SAS or SPSS or by reading the formatted data into a relational database like Access or Paradox. It is evident that the data are nearly complete by county but that they contain an “elsewhere” and a “not known” line. We have analyzed the unknowns for several states and we have found that they average about 1.5 percent of the county workforce – comparatively, the amount undetermined is relatively small.

By using the JTW data base engine included in the BEA REIS CD-ROM you can solve for all relevant counts in your labor force equations except for unemployment. You can solve for:

- how many persons work in your counties,
- how many of those workers are incommuters (and from where),
- how many workers live in your counties, regardless of whether they commute or not,
- and how many of those workers are outcommuters (and where they go).

From these counts we easily solve for all but the unemployed component of Equation 1 above. Unemployed counts we obtain from the 1990 U.S. census data to arrive at the completed labor force count for each county. Equation 1 can now be solved.

## Spatial Data

When we model the entire system of labor force equations, we feed in new estimates of incommuting and outcommuting (Equations 2 and 3). Another data need arises in the calculation of these new estimates. The equations include indigenous indicators for external labor force and external employment. In order to determine the external labor force and employment variables, we rely on spatial data for distance calculations. County coordinates (latitudes and longitudes) can be obtained from data sets provided with GIS software packages, or from the U.S. Census Bureau STF-3 data sets. In the Iowa model, we calculate population-weighted county midpoint coordinates using data from the U.S. Gazetteer.

**Figure 3. Data from the U.S. Gazetteer Data Set**

state	placefips	city	state	pop90	houses	landarea(km)	waterarea(km)	lat	lon
1	00124	Abbeville city	AL	3173	1320	40308	121	31567949	-85253681
1	00460	Adamsville city	AL	4161	1554	7948	0	33595542	-86957993
1	00484	Addison town	AL	626	286	7688	0	34199940	-87177921
1	00676	Akron town	AL	468	220	1437	0	32876118	-87738779
1	00820	Alabaster city	AL	14732	5144	48812	106	33226547	-86824620
1	00988	Albertville city	AL	14507	6238	66073	260	34262453	-86209414

More detailed procedures for calculating the labor force variables, including the indigenous indicators (external employment and labor force indices), will be described in Part 3.

## **Problem 2: Finding Relevant Social, Economic, and Physical Data**

There are still other data needs. Estimation of the remaining model equations requires sets of social, economic, and perhaps physical data. If you do not have access to 1990 census data for your state and its counties, you can contact the U.S. Census Bureau site at [www.census.gov](http://www.census.gov) or, for example, the Center for Earth Science Information Network site located at [www.ciesin.org](http://www.ciesin.org). Other useful sites include STAT USA at [www.stat-usa.gov](http://www.stat-usa.gov), the U.S. Bureau of Labor Statistics at [www.bls.gov](http://www.bls.gov), and your state departments of economic development or labor. If public safety issues are important, information on crimes, crime rates, and cleared crimes can be obtained from the FBI Unified Crime Report series, which can be obtained from [www.fbi.gov](http://www.fbi.gov) or from the printed series at the documents repository section of your library.

It is often the case that states keep good information on land values, transactions, and retail sales by community and county. Some compile good statistics on incorporations, business starts and failures, and other commercial statistics. States may also compile data on infrastructure inventories that can be incorporated into the data systems. Examples might include highways, bridges, and other roadways. The state may have a grading system as to the systems' age, capacity, and life-expectancy. State utilities commissions might have reliable information on other forms of private infrastructure like telecommunications investment, switching capacity, or fiber optic line miles. State hygienic laboratories might have very spatially specific information on water quality or waste water treatment capacities. By looking through your economic, social, and environmental data sources, you may discover new policy variables.

### **Problem 3: Obtaining Local Government Finance Data**

A major information need centers around accessing the U.S. Census of Governments data for 1992. The data are available in CD-ROM. Unfortunately, the data sets are massive, and the Census Bureau gives little guidance for analyzing the data. In short, first time users of the data will need to program extensively to read the files for their state. An alternative source is through Iowa State University. Analysts there will prepare, upon request, a set of documents and data for any state that contains the following:

#### **Figure 4. Fiscal Data Available from Iowa State University**

- Census of Governments, 1992 Finance Statistics Abstract
- The raw data for your state
- SAS program to read expenditure data from the raw data (*readexp.pgm*)
- SAS program to read revenue data from raw data (*readrev.pgm*)
- SAS program to extract selected expenditure categories from SAS output and write them to a text file for import into pc-based relational databases
- SAS program to extract selected revenue categories from SAS output and write them to a text file for import into pc-based relational databases
- SAS output file from the (*readexp.pgm*)
- SAS output file from the (*readrev.pgm*)
- Excel spreadsheet combining selected revenue and expenditure data from 1992 for all local governments of the requesting state



## **PART 3. COMPILING VARIABLES AND SELECTING THE LEVEL OF ANALYSIS**

### **Overview of Part Three**

#### **Objectives**

- ❑ Construct variables to describe the local force by solving for local employment, incommuters, outcommuters, unemployment, and total labor force size.
- ❑ Construct variables to describe regional labor force supply and demand conditions, with sensitivity to the number and distance of communities exerting influence on each locality.
- ❑ Use raw data to construct other descriptive variables such as percentages, indices, and shares.
- ❑ Process data from all sources to a consistent jurisdictional level, for example the county level.

#### **Assumptions**

- ❑ The average commuting distance between counties can be reasonably approximated with the right-angled distance between population-weighted county midpoints.
- ❑ The squared distance between counties is an adequate distance decay function when evaluating the influence of external employment and labor force size.

#### **Requirement**

- ❑ Data processing skills – especially data queries and matching.

## PART THREE

### Compiling Variables and Selecting the Level of Analysis

Gathering data and identifying relevant variables represent just initial steps in building the model. Processing the data and presenting them properly are the next important steps in the procedure. This section is intended to help overcome some of the hurdles typically encountered in processing the data for their eventual use in estimating the model equations.

#### **Problem 1: Solving for County Labor Force Values**

Using the data gathered in Part 2, we can solve for all of the elements in the labor force identity that were described in Part 1.

- Labor Force =  $f(\text{Place of Work Employment, Incommuters, Outcommuters, Unemployed})$  *or*
- Unemployed =  $f(\text{Labor Force, Place of Work Employment, Incommuters, Outcommuters})$

To begin, we use the journey to work data (JTW) that are contained in the Regional Economic Information Service (REIS) CD-ROM from the BEA. With a series of queries, we process the data by place of work (POW) and place of residence (POR). When we sort the data by place of work (POW) we identify the amount of employment in a county, regardless of county of origin. When we sort by place of residence (POR) we identify the employed portion of a county labor force – its workforce regardless of where it works. With further processing, we can isolate all of the incommuters (and their counties of origin), and all of the outcommuters (and their counties of work). With the addition of the unemployment variable from the census data, we can solve for total county labor force. Figure 11 graphically represents the procedures for solving the labor force elements.

#### **Problem 2: Determining External Labor Force, Employment, And Distance Values**

Although we obtain initial values for incommuters and outcommuters from the REIS data, their estimation in the system of equations demands that they be determined using distance and size relative to the contiguous area. To do this we must calculate the contiguous labor force and contiguous employment statistics that are intrinsic to the original system of equations constituting the labor force identity.

- Incommuters =  $f_i(\text{Employment, Contiguous Employment, Contiguous Labor Force})$
- Outcommuters =  $f_o(\text{Employment, Contiguous Employment, Contiguous Labor Force})$

These “contiguous employment” estimates are converted into external\* indices, which are derived from the following gravity equations:

$$\text{External Employment (XEMP)} = \sum_i \text{Contiguous Employment}_i / \text{Distance}_i^2$$

$$\text{External Labor Force (XLF)} = \sum_i \text{Contiguous Labor Force}_i / \text{Distance}_i^2$$

XEMP is the external employment index. It is composed of the sum of contiguous (or external) employment divided by distance squared for each county that interacts with a county in your study area. XLF is the external labor force index, and it is composed of the sum of contiguous (or external) residential labor forces divided by the distance squared for each county labor force that interacts with your study area.

For each county in your state, you will need to identify all of the counties that either employ residents from, or supply workers to that particular county. In Iowa, we create a table containing these county-to-county interactions. The table looks something like this:

**Figure 5. County-to-County Commuting Interactions Table**

County of Interest	Interaction County
19001	19003
19001	19005
:	:
19197	19003

Next, for each row in the table, we match the interaction counties with their respective employment and labor force data.

**Figure 6. Interactions Table with Regional Employment and Labor Force Data**

County of Interest	Interaction County	Interaction County Employment	Interaction County Labor Force
19001	19003	5,000	6,000
19001	19005	15,000	17,000
:	:		
19197	19003	5,000	6,000

---

\* We compile contiguous or external employment or labor force counts from the REIS journey to work data base that we gleaned for determining incommuters and outcommuters. In previous versions we physically edited the counties that were meaningfully attached to another. Given, however, that we are constructing an index whose value is more a function of the distance squared denominator, such precision is unwarranted if not ridiculous, and we can compile the statistics using all of the county data – thus the use of the word “external” instead of contiguous.

The next problem is the distance calculation. In Iowa, we first calculate a population-weighted midpoint for each county. Once calculated, the weighted midpoint coordinates are matched to their respective counties in the interactions table.

**Figure 7. Interactions Table with County Coordinates**

County of Interest	Lon1	Lat1	Interaction County	Lon2	Lat2	Emp	LF
19001	92.3	43.2	19003	92.1	43.2	5,000	6,000
19001	92.3	43.2	19005	92.4	43.5	10,000	12,000
:							
19197	92.6	43.6	19003	92.1	43.2	5,000	6,000

The population-weighted midpoint method works well for Midwestern states with relatively uniform county sizes, populations, and no meaningful physical barriers. The population-weighted midpoints are calculated from an U.S. gazetteer file downloadable from the U.S. census (see Part 2).

We calculate the distance as the right-angled distance between the two county midpoints. (This may be a less appropriate method to apply to mountain states where roads tend not to run at right angles). In the following spreadsheet example, the right angle distances are calculated (represented as XVALCALC and YVALCALC) and summed to obtain the GEODISTv variable, or the commuting distance between the pairs of counties.

**Figure 8. Data from the Distance Calculation Spreadsheet**

LON1	LAT1	LON2	LAT2	XVALCALC	YVALCALC	GEODISTv
-85.49023	33.667909	-94.8602	42.032285	508.81234	577.14197	1086.0
-86.18839	32.595902	-91.56698	41.689339	295.00596	627.44715	922.5

Whatever distance calculation method is used, once the distance between all pairs of interacting counties has been calculated, the distance squared value is appended to the interactions table. Figure 11 at the end of this section provides a graphical summary of the procedures described to this point. Next, for each line in the table, the following values are calculated: employment divided by distance squared, and labor force divided by distance squared. These values are summed by county of interest to obtain the overall external employment or external labor force index unique to each of the counties. Knowing these values, we now have all of the data needed to complete the original labor force identity.

### **Problem 3: Compiling Relevant Social Statistics To Include In The Model**

We'd all like our models to have rigorous hypothetical foundations. It has been our experience, however, that only a handful of social or economic variables at the county level determine variance in the fiscal variables – the labor force change variables do most of the

work. We organize our social or economic variables into three categories. Examples are enclosed in parentheses:

1. Family characteristics: (percent of married families with children, average number of children per household, percent of families with children in poverty, percent of children in poverty)
2. Workforce characteristics: (male participation rate, female participation rate, total participation rate, teen participation rate)
3. Economic characteristics: (firms, nonmanufacturing firms, manufacturing firms, average earnings, characteristics of income, etc)

We also recognize that there are physical or spatial characteristics that may be pertinent to the determination of local government spending. In our case total area/population is a useful variable as also is the percentage rural (or nonrural) in a county. For western states land tenure characteristics might matter, such as percentage of federal land or Indian reservation in a particular county. While the list of social and economic variables should somewhat inclusive, given the usual small increments to variance explained, it's recommended that we limit them to a useful set of key indicators.

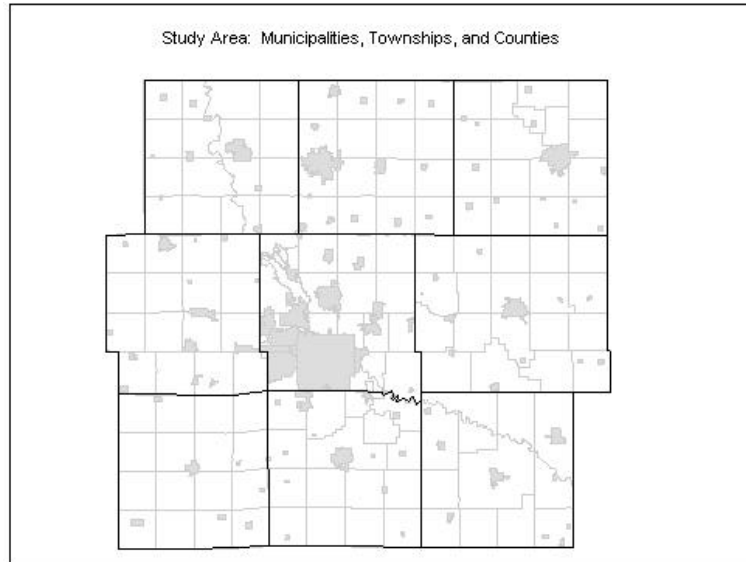
There are other variables that may be useful in explaining variance in the labor force and in the fiscal variables. Indeed, the trend may now be to include more economic variables as well as social variables into our community models. Before that is done, however, it is important to really know the jurisdictional specificity you need for the model.

#### **Problem 4: Jurisdictional Specificity and Data Availability**

More than a fair understanding of the spatial and institutional characteristics of political authority in your state of study is essential to properly constructing community impact models. By spatial we mean the physical geography of governmental jurisdictions. By institutional we mean roles, responsibilities, and public finance characteristics. Once learned, we need to know if they all are additive.

In Iowa, for example, we have 99 counties that are laid out in consistently-sized rectangles. Within these are 952 municipalities, 500 of which have populations of 500 or fewer persons. The political boundaries of most communities are contained within county boundaries. A snap shot of 9 central Iowa counties illustrates the city, township, and county grid in Iowa. The 9 large rectangles are counties. The small rectangles within the counties are townships. The irregular-shaped gray areas are municipalities. It is evident that municipalities tend to stay within county boundaries, but that they often cross townships.

**Figure 9. Possible Levels of Jurisdictional Analysis**



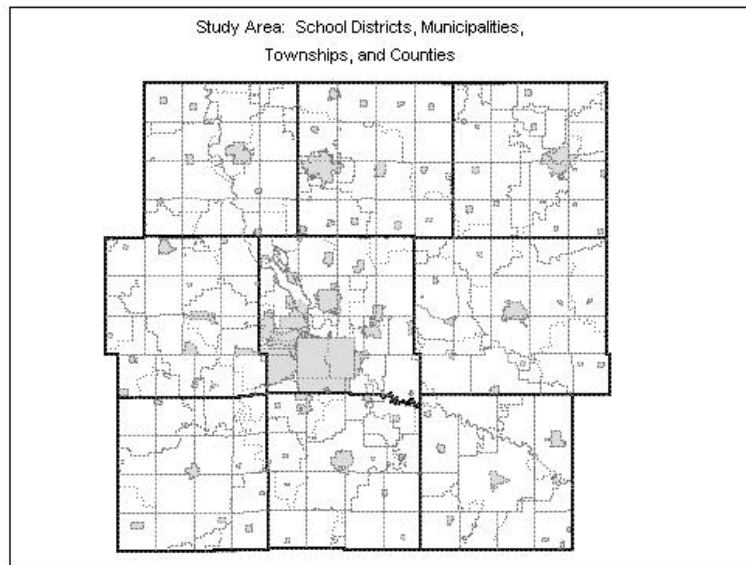
In this display of political geography, it is evident that the two most distinct levels of analysis for which data are available are the municipal and the county levels. While some data can be had at the township level, the fiscal data would not aggregate into the townships without using GIS estimation techniques. Social data from the 1990 census could be disaggregated into municipal and remainder of county subdivision (township remainder) levels, but precious little other data could be found at that level.

City and county governments account for just about half of local government spending in the state: the other half of local government spending comes from local school districts. School property tax collections amount to 46 percent of the total statewide and can go as high as 62 percent in some of the more rural counties. School districts account for nearly 85 percent of state government direct spending on local governments. Any community model that ignored the school districts would be incomplete.

The following display, however, demonstrates what happens when there is a misalignment of local government boundaries. The dotted-line represent just a few of the 360 non-geometric territories that are school districts. These districts have absolutely nothing to do with county or municipal boundaries. They were constructed considering much different historical circumstances: the existence of physical barriers to children's travel such as rivers, creeks, and bridges along with cultural, ethnic, or religious factors. The political space of school districts is quite incongruent with the space of the counties. Nearly all communities, however, are subsumed completely within a school district. This would allow for the aggregation at the school district level, but that would mean re-aggregating the county government portions or ignoring them altogether. Additionally, except for some census data, there is little if any other meaningful data collected at the school district level in political boundary circumstances like

Iowa. Other states have school districts that align with county boundaries. Aggregation at the county (or school district level) is not a problem for them.

**Figure 10. Example of Overlapping Jurisdictions**



To many analysts, public finance reduces simply to the taxes that we pay: sales, property, use, and income. The construction of most local government finances, however, is much more complex than taxes. This is especially so in light of the property tax revolts of 1979 and 1980 and the current climate of fiscal and service devolution, which was begun most notably, actually, during the Reagan Administration with the 1982 Omnibus Budget and Reconciliation Act. Add to that the transformations that have happened in many states and it is immediately evident that local government function, structure, and finance are complex.

In general, taxes pay only a portion of the local government service bill. In Iowa, for example, local taxes from all sources account for only 35 percent of local government general revenues. Transfers from the federal government and from state government may be substantial – especially in states that have equalized their education funding systems. In Iowa, over half of local school finances are transfers from the state. Similarly, local funding for roads and streets is primarily dependent on state sharing of road use tax fund receipts with local governments.

Besides these transfers, the complexity increases dramatically. Municipalities levy a host of charges and other fees to fund public services. For Iowa cities, charges represent a full quarter of their general revenue receipts: another 15 percent are retrieved from the ever-present “miscellaneous” category, which is comprised mainly of special assessments (land-specific charges) and earnings on investments. Finally, many communities operate local utilities and other enterprises. Gas and electric systems are found in many municipalities, and the state’s largest county actually owns a race track and casino. For the sake of consistency and

generalizability it is usually necessary to segregate general revenues and spending from utility and enterprise activities. Because the presence of county- or city-owned hospitals is irregular, we also exclude their specific revenues and expenditures so as to increase inter-community and county comparability.

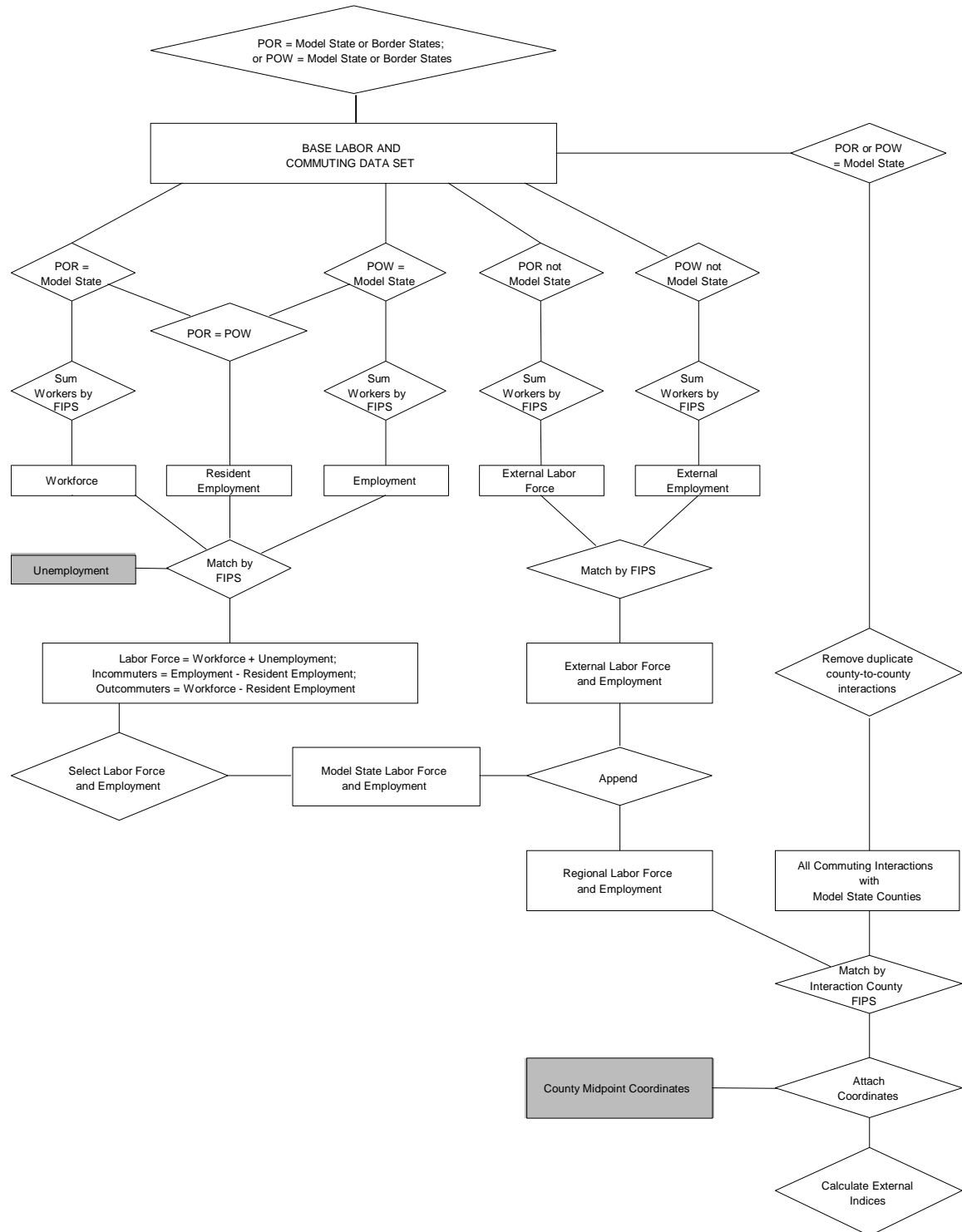
All of this complexity must be considered in light, too, of the wide variance in local government responsibility that exists among the states. The scope and amount of local government activity in Iowa differs markedly from that found in Missouri or South Dakota. Local government concerns in the corn belt may differ distinctly from those in the western mountain states, and so on. Modelers must, therefore, be sensitive to the geographic space as well as the political and functional space of local government activity.

The first models built in Iowa were at the county-government level and at the municipal level. Impacts were estimated for the city and for the county. Average school district revenues and costs were imputed for each county and included in the county-government model. We specified below the county level because municipalities were and still are our primary customers. We have constructed a new model that is at the county level and focuses on local government functions – education, transportation and roads, public safety, etc.— instead of specific local governments. To that model we have added economic variables, social variables, and environmental variables in an effort to describe a greater range of potential impacts besides labor force and fiscal outcomes.

It has been our experience that county-based models seem to be the most expedient and practical for most applications. Data availability drives this conclusion, as does experience. Analytic and functional comparability across states is another consideration. For western states county level analysis poses a problem, however, because of the scarcity and size of counties. In those instances, community or school district based models might be much more practical and descriptive. In other instances, multi-state models might be appropriate where economy and political structures are similar.



**Figure 11. Solving for Elements of the Labor Force Identity Using JTW Data**



## **PART 4. ESTIMATING AND EVALUATING THE EQUATIONS**

### **Overview of Part Four**

#### **Objectives**

- ❑ Estimate a set of equations with stable coefficients to describe the local labor force and fiscal characteristics of the communities in the model.
- ❑ Evaluate the equations and their coefficients to check consistency with theory and expectations.

#### **Assumptions**

- ❑ The variables composing the labor force identity are jointly determined, and should be estimated simultaneously as a system using a three-stage least squares procedure.
- ❑ The fiscal equations are ideally estimated using three-stage least squares; however, OLS or two-stage least squares estimation is adequate if the system is otherwise unstable.

#### **Requirements**

- ❑ SAS or other statistical software and programming skills.
- ❑ Understanding of regression analysis, its interpretations, and its limitations.

## **PART FOUR**

### **Estimating and Evaluating the Equations**

It has been strenuously recommended by those that know (or say they know) about these matters that the entire package of labor force and fiscal variables should be estimated as a simultaneously-determined system using three-stage least squares. Three-stage least squares combines two-stage least squares, which helps to eliminate simultaneous equation bias, with a method called seemingly unrelated regression analysis. Seemingly unrelated regression analysis is useful because when we estimate a system with many equations there is a high likelihood that the random errors in the equations are correlated. In practice, we have found that this is a real sticking point in finishing the models. Researchers trying to estimate a more rich set of revenue and expenditure variables will usually find it difficult to build a model whose coefficients are stable. Stability usually can be achieved initially by limiting the revenue and expenditure items, but that comes at the expense of analytic and descriptive detail.

Our advice is to not get hung up on this matter in the early stages of model building. Estimate the labor force change as a system. Get a feel about how well the equations are behaving. If the model proves unstable or the coefficients are in the wrong direction, look first for outliers or for a local government whose characteristics are exercising undue influence on the system. You might consider segregating the observations – building a nonmetro model, for example, or a model that eliminates very rural, non-typical counties. If none of these efforts help stabilize the model, don't despair. Build a prototype model using OLS equations for the fiscal or other social variables mindful, of course, of the biases intrinsic, and as time goes on work on re-estimating the model properly. In the mean time you'll have a model that is more applicable than not to local changes.

The goal of the estimation process is to create a set of equations that describes the interrelationships among labor force, fiscal, and other variables. The equations are used in two ways: to obtain baseline estimates for the predicted variables and to generate a set of coefficients that are used to simulate impact scenarios. Each model equation has one or more "driver" variable that stimulates the change in the predicted variable. It is important in the model for at least one driver variable in each equation is determined endogenously by the system; otherwise, you will simply be predicting constant changes due to an exogenous shock, which is usually a change in local employment. In the case of community models, that variable is usually population.

Nearly all of our initial analysis is done in SAS-Windows, although other programs, like Shazam, are also suitable.

#### **Problem 1: Specifying the Labor Force Equations**

A simultaneous system of equations represents the conceptual model of a regional labor force. The conceptual model is described in detail in Part 1, and reviewed in Parts 2 and 3. The

various components of labor force are estimated using employment as the exogenous variable, and labor force or unemployment as an endogenous variable. Using an identity statement to define the endogenous variable allows you to close the system and obtain reduced form estimates of the coefficients. The following excerpts from a sample SAS program (the variables names are listed for readability) show how the labor force equations might be specified.

**Figure 12. Initial Specification of the Labor Force Equations**

endogenous	labor force, incommuting, outcommuting, unemployment, population, enrollment;
instruments	employment, external employment index, external labor force index, external employment index * external labor force index (as an interaction term), total labor participation rate, wage index, area per capita, distance to MSA, unemployment rate, percent living in town;
identity	labor force / employment - incommuting + outcommuting + unemployment;
model	incommuting = f(employment, labor force, external employment index, external labor force index, area per capita);
model	outcommuting = f(employment, labor force, external employment index, external labor force index, wage index);
model	unemployment = f(employment, labor force, wage index, area per capita);

This system is very useful for providing baseline estimates of the labor force components in an “equilibrium” state. Unfortunately, such a system has limitations when external shocks are simulated.

We don’t expect a given employment change to stimulate identical impact scenarios in two counties of differing size or level of urbanization. However, when we apply the coefficients from our linear system of equations to an exogenous employment change, the marginal impacts are not sensitive to the individual county data. The simultaneous solution of the system occurs only during the estimation, not the application, of the model. The end result of estimation is a set of fixed coefficients that, when plugged into a spreadsheet model, produce fixed results across counties. Unless the working model is somehow fashioned to introduce variability from the endogenous variable (labor force or unemployment), a given change in employment produces fixed results regardless of individual county characteristics. Solving this problem can introduce others in applying the model.

In the applied model, changes in employment and labor force (or unemployment) stimulate the incommuting, outcommuting, and other impacts. The change in employment is introduced exogenously by the user as a shock to the system. Some other method must be chosen to obtain the initial change in the endogenous variable. Depending on the method chosen, coefficients that seemed reasonable during the estimation process can produce unreasonable results when they are used with actual county data.

We have maneuvered around the problem of fixed impacts by introducing additional equations to the linear system. First, we use the set of equations similar to those shown above

to generate the static, baseline estimates of incommuting, outcommuting, resident employment, and unemployment. We then obtain a baseline labor force estimate by solving the identity:

$$\text{LABOR FORCE} = \text{EMPLOYMENT} - \text{INCOMMUTING} + \text{OUTCOMMUTING} + \text{UNEMPLOYMENT}$$

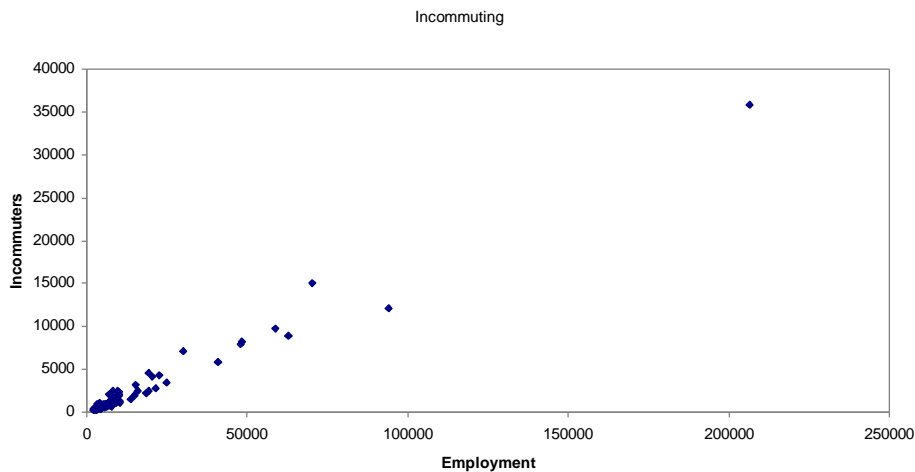
We next specify another set of equations to obtain coefficients that capture the dynamics of the labor force market. With the use of log equations, we estimate coefficients that produce varying impacts in the applied model. The impacts are sensitive to a county's base level of employment and commuting characteristics. We include these additional equations in the linear system above, so the coefficients are still determined with the three-stage least squares procedure. Sample model equations follow:

**Figure 13. More Labor Force Equations**

model	$\log \text{ incommuting} = f(\log \text{ employment, external employment index, external labor force index, distance to MSA, area per capita, wage index});$
model	$\text{outcommuting ratio} = f(\log \text{ employment, external employment index, external labor force index, wage index, distance to MSA});$
model	$\text{unemployment ratio} = f(\log \text{ employment, external employment index * external labor force index, wage index});$

The labor force equations should be structured to represent patterns characteristic of your state. For example, the following graphs show that incommuting and outcommuting in Iowa follow vastly different patterns when compared to county employment.

**Figure 14. Incommuting as a Function of Employment in Iowa**



**Figure 15. Outcommuting as a Function of Employment in Iowa**

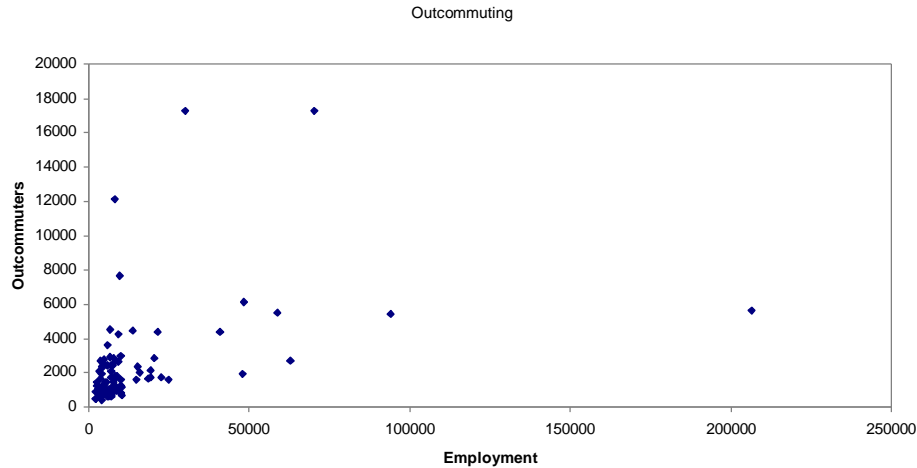


Figure 14 reveals that the ratio of incommuting to employment is nearly constant across counties in Iowa. The Iowa model's second incommuting equation simply estimates the percentage change in the number of incommuters associated with a percentage change in employment.

Figure 15 illustrates that outcommuting in Iowa is more difficult to explain. Aside from the county-by-county variance, there is a conceptual problem with predicting outcommuting impacts. The conceptual model in Part 1, which seeks to equate local demand and supply for labor, shows us that outcommuting subtracts from the local labor supply. When new jobs are available locally, we expect some of those jobs to be filled by residents who are currently commuting out of the county. This reduction in outcommuting effectively increases the amount of local labor supply now willing to forego the benefits of commuting. Unfortunately, modeling the outcommuting relationship is made difficult by the correlation among these three variables. Causality aside, larger communities simply have more jobs in their local economies, more labor force members, and more outcommuters than smaller communities. Therefore, if the variable for employment is used alone in the outcommuting equation, it has a positive coefficient. This creates a problem in the applied model: adding jobs to the local economy results in more people commuting out of the county. In the Iowa model, if we add a variable for labor force size to the outcommuting equation, it takes on a positive coefficient and leaves the employment variable with a negative coefficient. This equation is conceptually pleasing, because we not only expect outcommuting to decrease when new jobs are available locally, but to also increase with overall labor force growth. The problem again is with the application of the model. Depending on the coefficient estimates for the labor force and employment variables, the effects of predicted labor force growth often overshadow the effects of employment growth, and outcommuting still increases in the model. While this scenario might accurately represent an eventual "equilibrium" state, it is not very useful for short-term projections and policy simulations.

We have changed the focus of the outcommuting equation from its original specification. We estimate the likelihood of outcommuting instead of the actual number of outcommuters. Our equation predicts how the ratio of outcommuters to total labor force size will change with employment growth. This equation is sensitive to a county's existing commuting preferences. A log transformation of the employment variable makes the equation sensitive to the county's current level of employment, as well. This method produced a negative sign on the employment coefficient so the model gave us predicted changes in the expected direction.

The revised labor force module will produce baseline values for incommuting, outcommuting, unemployment, and total labor force. It will also predict the marginal changes in incommuting, outcommuting, and unemployment associated with an employment change. These marginal changes can be plugged back into the labor force identity equation to obtain the estimated change in total labor force size. To complete the labor force module, we specify equations that estimate population as a function of labor force, and enrollment as a function of population (or labor force).

**Figure 16. Completing the Specification of the Labor Force Module**

model	population = f(labor force size, total labor participation rate);
model	enrollment = f(population, female participation rate, married families with children);

## **Problem 2: Specifying the Fiscal Equations**

The second module in our model contains the fiscal, retail, industry mix, and property valuation equations. These equations are all population-driven. The full Iowa model has 51 equations in the second module. The web-based model in Iowa is much simpler, and its fiscal component is reproduced here to illustrate the specification of equations. First, we defined and combined categories of revenues and expenditures from the raw data.

**Figure 17. Combining Revenue and Expenditure Categories**

safety	= police protection expenditures + fire protection expenditures;
admin	= financial administrative expenditures + general public buildings expenditures;
other revenues	= total general revenues - state government revenues - property tax revenues;
other expenditures	= total general expenditures - education expenditures - safety expenditures - admin expenditures - streets & roads expenditures;
surplus	= total general revenues - total general expenditures;

The program includes an identity statement to balance the system.

**Figure 18. Sample Fiscal Identity Statement**

Identity	surplus / total general revenues - total general expenditures;
----------	--

Next, the we specify the fiscal and retail equations.

**Figure 19. Specifying the Fiscal Equations**

model	state government revenues = f(population, per capita income, percentage of income from wages & salaries, area per capita, percent high school graduates);
model	property tax revenues = f(population, per capita income, percent living in town, percent residential land, percent agricultural land);
model	other revenues = f(population, area per capita, distance to MSA);
model	financial administration = f(population, percent poor, rural capacity, percent living in town);
model	public buildings administration = f(population, rural capacity, area per capita);
model	streets & roads = f(population, population change rate, urban capacity, area per capita);
model	police protection = f(population, percent commercial land, firms per capita, rural capacity);
model	fire protection = f(log population, population density, residential valuation per acre, per capita income, married families with children, trade area capture);
model	education = f(population, percent service firms, married families with children, percent high school graduates, percent agriculture land, distance to MSA);
model	other expenditures = f(population, per capita income, population change rate, distance to MSA);
model	surplus = f(population, resident employment per capita, firms per capita);
model	retail sales per capita = f(population, outcommuting per capita, residential valuation per capita, married families with children, percent agricultural land, total labor participation rate, percent manufacturing firms);

### **Problem 3: Evaluating the Model**

Logic dictates the original specification of the equations. Practical factors that are, perhaps, alien to logic will probably shape their final specification. After all of the programming errors have been detected and corrected, the program is run to obtain estimation results. It is important to examine the results of each equation to determine how the individual variables perform within the model and how the overall model fits the data.

Finding the right mix of variables to include in each equation will take some time. The hypothetically consistent choices might not always prove to be useful. The problem of multicollinearity is often to blame. Many of the variables in the data sets are highly correlated with one another, which makes it difficult to sort out their individual contributions to a model. For example, the following table shows the correlation between three important variables in the Iowa model.



**Figure 20. Correlation Between Independent Variables**

	<i>External Employment</i>	<i>External Labor Force</i>
	<i>Index</i>	<i>Index</i>
External Employment Index		
External Labor Force Index	0.9956	
Total Labor Participation Rate	0.4960	0.5098

The correlation of 99.56% between the two external indices has caused headaches in the specification of the model's commuting equations. The coefficient estimates for these variables are frequently in the opposite direction than we expect, and they may flip about when new variables are introduced to the equations. These are classic signs of multicollinearity. If the sign of a coefficient estimate is positive, when logic suggests that it should be negative (or vice versa), consider using a different mix of explanatory variables. When multicollinearity is present in a model, the overall model can still be useful. However, interpretation of the individual coefficient estimates is usually discouraged. This is a troublesome problem in fiscal modeling because of our reliance on the individual coefficients to simulate impacts.

Another common problem is that variables that we expect to have a positive or negative outcome on a particular type of public expenditure sometimes do not explain variance in expenditures. Here we run across aggregation biases, or in some instances the Robinson fallacy when things that ought not be predicting something are. When constructing the equations a good rule is the fewer the variables the better. We are usually not explicitly trying to maximize variance explained; instead, we are trying to produce stable and predictive coefficients of change.

How reliable are our estimates? Some of the common procedures generally used (and misused) to evaluate regression models are not relevant for this type of analysis. For example, the following SAS output shows estimation results for per capita financial administration expenditures in the Iowa model.

**Figure 21. Sample SAS Output from Model Estimation**

<b>Model: FINANCIAL ADMINISTRATION</b>					
Dependent variable: Financial Administration Expenditures					
Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	4	3548.27276	887.06819	9.732	0.0001
Error	92	8385.93101	91.15142		
C Total	96	11934.20376			
Root MSE		9.54733	R-Square	0.2973	
Dep Mean		37.61890	Adj R-SQ	0.2668	
C. V.		25.37906			

Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T
INTERCEP	1	18.879911	7.173873	2.632	0.0100
POP90	1	-0.00008043	0.000025626	-0.314	0.7543
PCTPOOR	1	0.655379	0.353819	1.852	0.0672
RURALCAP	1	0.141527	0.028156	5.027	0.0001
INTWNPCT	1	-0.071242	0.035650	-1.998	0.0486

SAS and other statistical programs calculate a t-value and a probability for each coefficient estimate. Normally, we use these parameter measures to help reject the null hypothesis that the coefficient is actually zero. Testing this hypothesis at a 95% level of confidence means that 95 out of 100 randomly drawn samples from the normally distributed population would produce a coefficient that supported rejection of the null hypothesis. However, because the data used in the model represent all of the counties in a state, they **are** the population, and they are **not** always normally distributed – how they are distributed is normal for their state but not necessarily normal for us. T-statistics and the associated probabilities are technically irrelevant. This said, we might still use them to guide us when building a model. If the t-value is extremely low, it could suggest that the variable is not contributing much to the overall explanatory power of the model and can probably be thrown out. Conversely, if it feels hypothetically correct to keep the variable even though it doesn't appear to contribute much to the variance explained, it probably doesn't hurt to keep it in the equation.

For some equations, the overall  $R^2$  values may also look low. This does not always signify a bad or mis-specified formula. For example, the SAS output above shows that the Iowa model explains less than 30% of the variance in per capita financial administration expenditures. However, this category of spending is relatively constant across the state. There just is not much variability for the model to explain.

Conversely, a high  $R^2$  value is not always a good thing. In the Iowa model, we were able to explain 70% of the variability in per capita fire protection expenditures, which ranged from \$3.50 per capita to \$88 per capita. Although the overall model provided a good fit to the existing data, the impact scenarios predicted for our most populous counties were alarming. We have encountered this to such an extent that we have given it a name: we call it the “X@?#\$!! Big Place Problem.” We have just a few observations from very large places, which often makes them very influential in the estimation of coefficients. The slope of the fitted line is often so extreme at the tail ends as to make the model unreliable for predicting marginal changes in an impact scenario – especially for the largest and smallest places. The following graphs help illustrate this problem.

**Figure 22. A Linear Model**

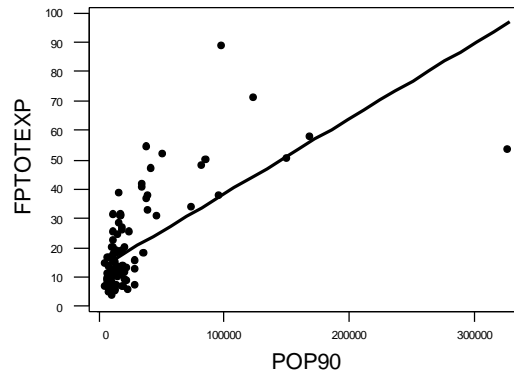


Figure 22 shows a fitted line plot for a simple regression model. We are using population as the independent variable to explain variance in per capita fire protection expenditures. This simple model would be adequate for Iowa's smaller counties, but it misses the observation for our largest metro county by a wide margin. We could try to improve the fit by introducing curvature with a quadratic term.

**Figure 23. A Quadratic Model**

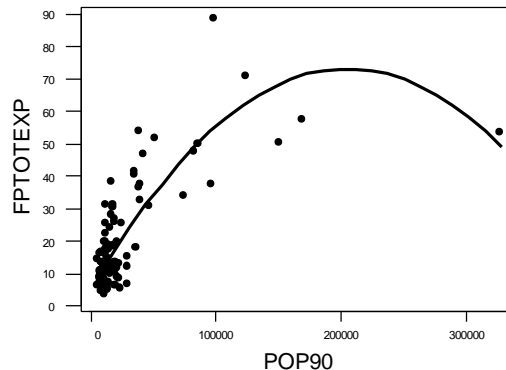


Figure 23 shows a fitted line plot for a model with population and population squared. The fit looks very good, but the slope of the fitted line suggests that a small increase in population in our largest county would lead to a relatively sharp decline in per capita fire protection expenditures. In some impact scenarios, this model might even predict a decline in total (not just per capita) fire protection expenditures. In cases like this, where the quadratic term introduces too much curvature to the model, we have found that a log transformation can be helpful.

**Figure 24. A Log Model**

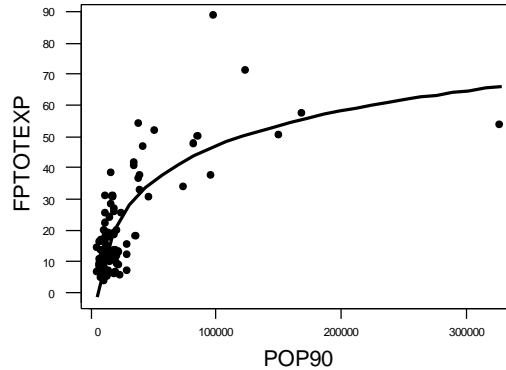


Figure 24 shows a fitted line plot for a model with the log of population as the independent variable. The quadratic model might appear to be a better fit; however, on the margin, the log model seems to work better for simulating impacts. A log transformation gives the population coefficient estimate a nice interpretation. It tells us the expected change in per capita spending associated with a percentage change in population. The slope of the fitted line in this particular model suggests that, for a given population increase, per capita fire protection expenditures rise more sharply in smaller counties than in larger counties.

All of this suggests a useful way to evaluate model equations without relying completely on numerical diagnostics. Graphical plots of the raw data, the fitted values, and the residuals often identify problems and reveal patterns that lead to better models. The graphing functions in statistical software packages such as SAS Windows and Minitab are easy to use. Taking some extra time for graphical analysis during the estimation phase might save a lot of time later, especially if it helps identify problem equations *before* the entire simulation model has been assembled.

Deciding when a model is “good enough” is, in the end, a matter of personal judgement. It is easy to wander about on an obsessive search for ever-better equations. Don’t forget that the goal is to construct a useable model that provides reasonable estimates of change. The data used to build the model are imperfect, local government behavior does not always align with our expectations, and people are probably waiting for the finished model.

## **PART 5. CREATING THE IMPACT ASSESSMENT SPREADSHEET OR DATABASE**

### **Overview of Part Five**

#### **Objectives**

- ❑ Design a dynamic framework for a model that will simulate impacts using the coefficients and data generated in previous steps.
- ❑ Build the simulation model using formulas and functions that facilitate its use, and reports that enhance the presentation of its output.

#### **Assumptions**

- ❑ Coefficients obtained from the simultaneous estimation process are reliable when used individually to simulate impacts.
- ❑ The *types* of impact assessments conducted with the model will be relatively consistent in nature.

#### **Requirements**

- ❑ Understanding of the model's intended applications and the informational needs of its target audience.
- ❑ Experience with spreadsheet or database software.

## **PART FIVE**

### **Creating the Impact Assessment Spreadsheet or Database**

You can view the simulation model as a shell for the data you have generated in the previous steps. The software and structure you choose for the shell depend on the model's intended use and target audience. The model's basic functions are to look up data, perform calculations, and present results; thus the basic elements of the model are data sets and lookup functions, formulas, and reports. You can mechanize the model's functions and dress up the results to whatever degree you choose.

#### **Problem 1: Choosing the Software**

In Iowa we have built models using spreadsheet and database software. While spreadsheet programs offer ease in data manipulation, database programs offer ease in data retrieval. In general, we have found that spreadsheet software supports our models more efficiently and effectively than database software. Both types of software have built-in functions that can make the impact assessment model user-friendly.

Spreadsheet models are easy to build and navigate. In a spreadsheet model, the formulas and structure are visible. You can organize the data, calculations, and final results (including graphics) on separate sheets in a notebook to keep from cluttering up the spreadsheet. One drawback to a spreadsheet model is that the formulas reference specific cells. If you change the equations or structure of the model, you must carefully check the formulas to make sure they still refer back to the correct cells. The inability to solve equations simultaneously is another limitation of both spreadsheet and database models. If the equations are too complicated or if the formulas have circular references, the model simply blows up right before your eyes. Backups are really important!

The structure of a database model requires more careful planning than a spreadsheet model. In many ways database model building requires significant programming or programming-like skills. In a well-planned database model, information can be updated quickly by importing new data into the tables. A database model behaves, however, very much like a "black box," with the structure and calculations less visible to the user. These attributes make a database model well suited, for example, to Internet applications or, perhaps, for distribution to field staff who would not be required to modify coefficients or update data sources. These attributes also make a database model harder to build. Because the calculations are performed in a series of queries, care must be taken in sequencing the equations. It is more difficult to trace the source of errors. Inexplicable results in the early versions of the Iowa database model almost led to its christening as the "Random Impacts Modeling System." The acronym RIMS, unfortunately, was already spoken for.

## **Problem 2: Designing the Structure**

The basic components of the model are similar, regardless of the software used to assemble them. As noted above, these components are data sets, lookup functions, formulas, and reports. You can arrange these elements in a number of ways. A simple design allows quicker assembly, but it doesn't allow for easy modification. A complex design, while harder to build, might be more flexible and easier to operate. Some considerations in building the components of the model are discussed below.

### **Data Sets**

The Iowa model draws from two data sets. The first data set contains each county's predicted, baseline values for all of the dependent variables and the independent "driver" variables in the labor force and fiscal equations. The second data set contains the estimated coefficients for the model equations.

#### *Predicted Values*

You can instruct SAS to create output data sets that include the predicted values for the endogenous (dependent) variables and actual values for the exogenous "driver" variables. SAS Windows allows you to export these output data sets into worksheet or database format. A portion of the data set from the Iowa model is shown below. The table contains actual values for employment, external employment and labor force indices, and predicted values for incommuting, outcommuting, resident employment, and unemployment. These values are used as the baseline values for impact scenarios.

**Figure 25. Predicted Values Data Set**

COFIPS	POWEMP	EXEMPINX	EXTLFINX	EXEMXLF	P_INCO	P_UTCO	P_RSEMP	P_UNEMP
19001	3312	82.1993021	86.9370284	7146.16305	349.59	829.75	2944.58	280.74
19003	2261	38.482556	41.7002318	1604.73151	114.25	169.18	2115.88	211.22
19005	6449	43.6667837	52.3004556	2283.79268	887.39	927.46	5563.05	232.04
19007	5461	27.9212085	33.6602937	939.83608	708.25	1012.39	4745.29	275.71

#### *Coefficients*

Using the predicted values from SAS as the county baseline values eliminates the need to keep all the coefficients from the equations estimated in Part 4. Only the coefficients for the "driver" variables are required to process an impact scenario. You can write a program statement to create a SAS output data set that contains the coefficient estimates. With a few additional program statements, you can specify that only the three-stage (or two-stage) least squares estimates for the specified driver variables be included in the data set.

In the Iowa model, the labor force impacts are calculated first. The labor force impacts drive the population change. We then feed the population change into the fiscal and other equations. To ensure the proper sequence of calculations, we split the coefficients into two data sets: labor force coefficients and fiscal/other coefficients. The following table

shows part of the labor force coefficients data set. The coefficients in this example would be used to calculate the expected change in incommuting (loginco) and likelihood of outcommuting (outratio) from an employment shock locally (logpow), and/or changes in the external environment (exempinx, extlfinx).

**Figure 26. Labor Force Coefficients Data Set**

MODEL	POWEMP	EXEMPINX	EXTLFINX	EXEMXLF	LOGPOW	LF90	POP90
LOGINCO		0.00	0.00		0.96		
OUTRATIO		0.0007915	4.7058E-05		-0.19262933		

The fiscal coefficients data set has a similar format, but includes a different set of driver variables. The driver variables in the fiscal equations are population percentage change (LOGPOP), population change (P\_POP90), and squared population change (POP90X2).

**Figure 27. Fiscal Coefficients Data Set**

MODEL	LOGPOP	P_POP90	POP90X2
FRFEDGOV	31.0554751		
FRSTAGOV		0.000326997	
FRLOCGOV		9.53114E-06	
PROPTAX		0.000214785	

## Lookup Functions

In order to process an impact scenario, the model must first look up specific pieces of data from the data sets. Data lookup is one area where database models have an advantage over spreadsheet models. Relational databases work from tables of data. The columns in a table can be given descriptive names. The rows in a table are treated as data units. You can retrieve a row of data by specifying a value that is unique to that row (e.g. a county's FIPS code). By specifying both a row name and column label, you can easily retrieve specific data from your tables without actually knowing its precise physical location.

Regardless of the software chosen, the model must first allow the user to select a county for the impact scenario. Current versions of both spreadsheet and database software allow you to create "drop-down lists," from which you may select a particular value. The software uses the selected value to locate a corresponding record from another data set. This method is useful for retrieving the county-specific predicted values for the variables in the model.

After the county-specific data have been retrieved, the model must locate the appropriate coefficients to calculate impacts. If you create a spreadsheet model, you can perform the coefficient data lookup yourself as you build your formulas. To include a cell value in a calculation, you can just click on that particular cell. When you build formulas in



this way, the cell address becomes part of the formula. By investing some additional time, space, and data into your model, you can take advantage of the lookup functions built into software programs. These functions make a spreadsheet model operate more like a database model. Combinations of the vertical lookup, horizontal lookup, and match functions can be used to find a specific piece of data by name, rather than by cell address. When you choose your method of data lookup, consider how much you plan to tinker with the model structure and equations. If you don't plan to make many changes, the point and click method is probably adequate.

## Formulas

When creating formulas, spreadsheet models have the advantage over database models. Spreadsheet programs like Excel allow for fast and easy formula building. You can create formulas that include references to other calculated cells, and all of the cell values are updated together. You have the option of locating the formulas on the same or different pages in your notebook. In database programs like Access, calculations must be performed in queries. The nature of the fiscal impact models requires several layers of queries, with each query using the results of a previous query.

To illustrate the calculations required for an impact scenario, consider the effect of 1,000 new residents on total education spending in Adair County, Iowa. For this equation, the model requires the following data: the predicted baseline population for Adair County, the predicted baseline per capita education expenditure for Adair County, and the estimated coefficient for the population variable in the education expenditure equation. Next, the following calculations are performed:

### Figure 28. Calculating the Impacts

1.  $\text{Population Change} * \text{Education Equation Population Coefficient} = \text{Per Capita Impact}$
2.  $\text{Baseline Per Capita Education Expenditure} + \text{Per Capita Impact} = \text{New Per Capita}$
3.  $\text{Baseline Population} + \text{Population Change (1000)} = \text{New Population}$
4.  $\text{Baseline Population} * \text{Baseline Per Capita Education Expenditure} = \text{Baseline Total}$
5.  $\text{New Population} * \text{New Per Capita} = \text{New Total}$
6.  $\text{New Total} - \text{Baseline Total} = \text{Total Education Spending Impact}$

(The model might also include a formula to calculate the percentage change over the baseline estimate, and it should also inflate dollar impacts to current values.)

The formula building process would be easier if we just multiplied the expected population change by the per capita impact, and added or subtracted this amount from the baseline total to obtain a new total. However, this method does not fully reflect the effects of a change in per capita revenues or expenditures.

## Reports

The final step in assembling the model is designing reports that summarize the results. Using database software, you can design and save custom reports that trigger all necessary calculations when they are opened. With spreadsheet software, you can present the results in tables and graphs. The following exhibit shows a summary page from the Iowa model.

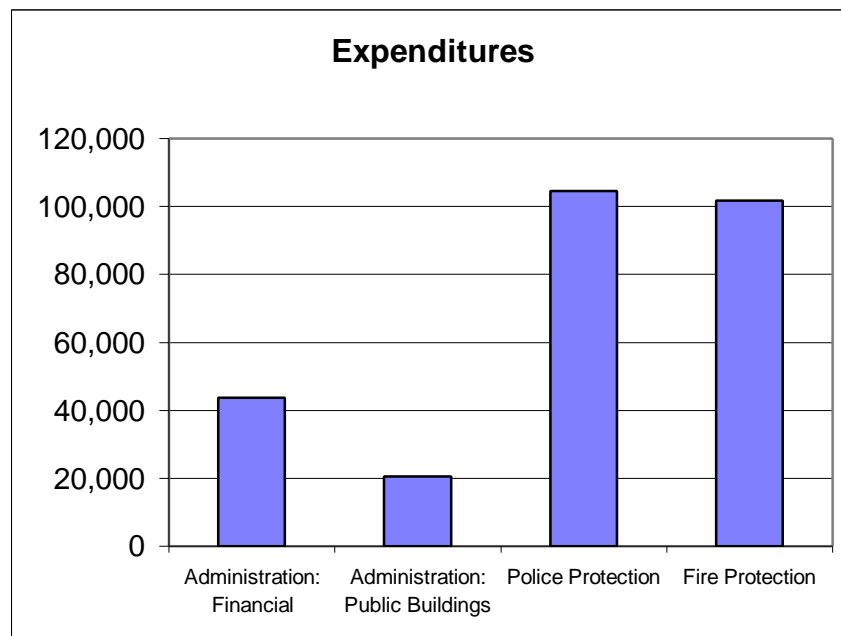
**Figure 29. Sample Impact Summary Report**

IOWA FISCAL AND ECONOMIC IMPACT ASSESSMENT MODEL			
<b>Study County:</b>	Story		
<b>IMPACT TYPE</b>	Local Employment		
<b>AMOUNT:</b>	1000		
<b>INFLATE TO YR:</b>	1997		
<b>Labor Force</b>	Employment Change	1000	
	Resident Employment	829	
	Incommuting	166	
	Outcommuting	-200	
	Unemployment	-21	
	Labor Force	613	
	Population	1115	
	Enrollment	201	
<b>Fiscal Impacts</b>	Beginning Balance	56,423	
<b>Revenues</b>	State Government Revenues	894,179	
	Property Tax Revenues	902,935	
	All Other Revenues	747,271	
	Total General Revenues		2,487,962
<b>Expenditures</b>	Administration: Financial	43,690	
	Administration: Public Buildings	20,541	
	Streets & Roads	237,434	
	Police Protection	104,634	
	Fire Protection	101,750	
	Education	1,243,618	
	All Other Expenditures	743,940	
	Total General Expenditures		2,495,608
<b>Trade Impacts</b>	Retail Sales Per Capita	11,252,472	

The spreadsheet model actually comprises several notebook pages, but all interaction with the user occurs on this particular page. Once the user selects a county, the type of impact, the impact amount, and the desired inflation year, the scenario results are displayed. The labels, instructions, and headings on the page are fixed. The cells containing the impact values reference separate worksheet pages, where the formulas are located and the calculations occur.

Another method of presenting scenario results is to create charts. For example, the summary page displayed above can serve as the source page for a set of bar charts that provide the user with a graphical impact summary. Selected revenue and expenditure categories can be compared, as in the sample chart below.

**Figure 30. Sample Graphical Impact Summary**



The examples in this section are all based on a spreadsheet model. Reports and charts in database models offer similar flexibility in construction. Once the basic elements of the model have been assembled and the model is functioning correctly, the possibilities for displaying results are endless.

## **PART 6. USING THE MODEL**

### **Overview of Part Six**

#### **Objectives**

- ❑ Help communities assess possible outcomes of economic, demographic, or other structural changes.
- ❑ Facilitate local government decisions and improve the choices available to local leaders.

#### **Assumptions**

- ❑ Local governments are aware of the benefits of such a service.
- ❑ Analysts have an academic and practical understanding of local government, economic, and social structures.

#### **Requirements**

- ❑ Cooperation from research sponsors and/or local government for information about area economic strengths and weaknesses, local government services, functions, evolution and practices.
- ❑ Familiarity with IMPLAN or some other Input-Output analysis system.
- ❑ Delivery mechanisms to include reports, newsletters, and web-based systems.
- ❑ Institutional commitment to facilitating the research & service activities.

## **PART SIX**

### **Using the Model**

Community impact modeling applications depend in large part on the state in which the analysis is taking place. It cannot be emphasized enough that the users of these models must have a decent understanding of local government structures, functions, evolution, and practices before the models are applied to communities or counties. Local officials are long leery of “experts” more than willing to tell them a better way to do local government. They have been extended, annexed, consolidated, privatized, reformed, frozen, mandated, home-ruled, downsized, devolved, and right-sized. They’ve seen grants come and go – mostly go, and they have more carrots hanging in front of them than they could possibly eat. They’ve watched their collective capacities grow and wane. And as they have struggled, they’ve watched the stakes increase, especially in terms of environmental compliance and rational land-use policies. They are acutely aware that what they do as a government differs markedly from what they had to do in the 80s or the 70s; and they know full well that what they do in the next decade will differ markedly from what they are currently doing. They also know that they are liable for their mistakes and that there are very real consequences to their decisions. Community models can be tools for exploring some of these consequences.

The applications of community impact models are determined by the kinds of questions and issues that dominate local government decision making, the availability of data, and the aggregate skills of the analysts doing the work. As these models have evolved over the years, it is evident that there are distinct differences in how each state applies them. There are, however, some generally common steps to any analysis. First, some change in local jobs, labor supply, or population is introduced for an area of analysis. Second, the changes are modeled as an impact or as a change scenario to be assessed over time, say over a 5 or a 10 year period.

### **Changing Local Employment, Labor Supply, Or Population**

Recalling the discussion in Part I, we know that the community model is designed to simulate changes in the components of the labor force (resident work force, incommuting, outcommuting, and unemployment) as a result of some external change. The usual change scenario involves some change in the demand for labor locally due to an employment “impact,” either growth or decline. Once the original equations are established, however, the model can simulate the expected community response to a change in any of the component variables in the labor force identity. The magnitude of the initial change that is introduced to the model is often determined using input-output analysis and regional economic assessment.

### **Input-Output Analysis**

The community impact models were designed to work in conjunction with input-output models, like IMPLAN. They are compatible in that both are originally constructed on a county basis: the study areas coincide. The use of IMPLAN is usually limited to

estimating the total job, income, or output effects of some industrial change scenario. The I-O model can also be used to simulate a set of changes in a local economy (increased tourism, decreased manufacturing, etc.) so that different scenarios could be assessed over a period of time.

By themselves, I-O models have limitations for economic analysis at the community level. The community impact model allows the analysts to be more sensitive to local economic characteristics when interpreting the I-O results. I-O structures measure inter-industrial transactions and the overall regional probability of the transaction occurring within the study area. The I-O model has good information on industrial earnings averages and production factors. The I-O model does not, however, have a clue as to where the workers live who work in the industries in the model. The I-O assumes the jobs are filled by net immigration. The community model allows the analyst to apportion the economic impacts, especially the induced values, into or out of the study area depending on estimates of labor force growth and changes in the levels of incommuting and outcommuting. Even though we rely on the I-O results to shock our community model, there is the opportunity to modify the exogenous change by using the initial values of the community model to modify the I-O results. The modified I-O results can then be fed back into the community model to get a more soft or robust estimate of expected fiscal or economic change locally.

We find that using the two separate models together allows a better overall impact assessment of the economy, likely labor force growth, and the expected changes in local government costs and capacities. The combination of the two allows us to apportion household effects to a larger territory than I-O would allow. Having done so, we get the opportunity to modify the job effects to a more realistic level of expected local growth and, therefore, expected impacts on local government systems.

### **Regional Economic Assessment**

Overall familiarity with IMPLAN or some other I-O system is an important prerequisite to conducting community impact analysis. So, too, is knowledge of the overall area economic strengths and weaknesses. We find that is important to explain the economic effects very carefully and with as much foreknowledge of the area economy as possible before we even get into the labor force and fiscal effects. In general that means that we have done a good preliminary assessment of the regional economy, its dominant structure, its changes over the years, and characteristics of the local governments within the study area.

The regional assessment is the most important analytic prerequisite to doing quality scenario assessment for the community. Research sponsors often have a growth agenda that they want to promote to the local community. That growth agenda might involve significant change in the overall structure of the local economy. It might also involve several categories of risk-taking on the part of local government and the citizens that fund it. The analyst has an obligation to assess, using standard applied techniques, the overall competitive advantages and weaknesses of the local economy as well any dominant trends that are present. For the regional analyst, this usually presents an excellent opportunity to help local and influential decision-makers understand the forces and factors influencing economic

activity and population change at the local level. This is also a chance to conduct a preliminary assessment of the local government fiscal situation, to include comparisons to other “lighthouse” communities or to the baseline estimates from the fiscal model.

### **Manipulating The Model To Test Scenarios And To Forecast Trends**

It is possible, indeed desirable in some instances, to use the community model to test for different types of change scenarios. If we recall the equation set from Part 1 we know that the system of equations yields expected labor force, incommuters, outcommuters, and population changes given an exogenous shock. Either population change or labor force change is then used to simulate fiscal and other policy impacts. All of these equations can, however, be solved in reverse order to arrive at, for example, expected labor force size and changes in the components of the labor force given a rate of population increase, expected growth in employment given a change in either population or labor force, overall effects of changes in incommuting or outcommuting, etc.

Scenario tests of this sort are useful in situations where there are a lot of changes going on in an area’s economy. If, for example, there has been a substantial shift in the number and probability of outcommuting in an area due to neighboring growth, then impacts attributable to some level of change in outcommuting might be more appropriate than trying to impute local employment changes. Similarly, if because of boom growth there has been a great rise in incommuting, but analysts wish to impose an in-migration scenario over time, then that too can be accommodated with the community model.

This leads us to one of the more important possible uses of the community model: analyzing fiscal items over time. The community model allows us to simulate changes in the supply of revenues and the average demand for local government services given changes in the labor force or employment locally. The coefficients in the model are sensitive to population size and different community attributes. The model gives the best guess on the amount and kind of service changes that will accrue as the local labor force changes over time. Analysts can incorporate changes scenarios into an assessment of expected changes in fiscal items over time.

The general procedure for this is to prepare a labor force and fiscal baseline for the community under study. Labor force, employment, and population size are determined from whatever current sources are available. Local government records can be used to determine per capita fiscal levels, as well. All of these baseline values represent the starting point in the analysis. Because the model compiles estimates of changes for each labor force and fiscal variable, each line has an expected rate of change given pre-stated assumptions about employment, resident labor force, or population growth. By adding the marginal changes to the respective baseline values, we compile estimates of growth for labor, demographic, and fiscal variables. We can vary our change rates over time to give us different possible outcomes. The whole point is to generate a range of responses that relate directly to assumptions about economic, labor, or population changes locally or regionally.

The simulation exercises can be very useful for local government planning and planning of responses to change. Simulations like this, for us, however, are relatively rare. Local governments in Iowa, especially city governments, are much more near term focused. Accordingly, we are only rarely asked to do scenario assessments involving multiple years. Usually we compile straightforward impact assessments attributable to a known or planned economic event.

### **Impact Analysis: The Iowa Experience**

We usually face a situation where a local government is working with a prospective or an expanding firm. The nature of economic development in our state allows the state Department of Economic Development and local governments to offer a variety of development incentives ranging from actual cash or cash-like payments, loan subsidies, short and long term tax breaks, and a panoply of subsidized job training programs. Local government concerns usually relate to balancing the very real need to promote consistent but stable growth in an area in light of these incentive options and the current capacity to fund local government services. New or expanding firms have become adept at “shopping” for the best deal among the several communities that they show an interest in whether or not the deal is truly part of their development choice or not— or for that matter whether the community is on their list of sites or not.

The typical impact scenario involves a labor and fiscal assessment that is conjoined to in I-O study of a regional impact of an industrial change. Normally, the communities contact us, either in conjunction with or separate from the Iowa Department of Economic Development. The Iowa Department of Economic Development reimburses communities for using the Iowa model to assess a change scenario. In most cases, however, the community knows of our capacity and simply wishes to get a handle on the possible impacts.

The general approach is to prepare a thorough assessment of recent economic change in the county and community of study. We also do a comparative assessment of the community’s fiscal performance – especially with regard to their local capacity to generate needed revenues and their comparative effort in doing so. We investigate current and planned capital improvement projects in order to gauge their infrastructure capacity. We also assess their revenue and general governmental bonded indebtedness to ascertain the overall near-term and long-term fiscal condition of the community.

All of this information is compared to a historical assessment of population and other demographic considerations in the community and the region. While much of the assessment of the community is conducted using readily available secondary data, much also is done using information collected from the city and county governments that are assessed. This mix of primary and secondary data collection allows us to be both contextually and temporally on target with our community’s current status in the region, and it allows us to better understand the factors and forces determining the decisions that the community is facing.



After a regional I-O is conducted, we apportion the expected jobs to the impact counties and communities using, for the most part, exiting workplace versus place of residence preference ratios in the region. Although I-O results produce job change estimates we assign those changes as employed persons in the communities and counties that we assess. Having done so, the Iowa model then re-balances the community's and the county's labor force and population totals. The following figure shows the usual display of information involved in a labor force and fiscal assessment for a county.

**Figure 31. Sample Impact Assessment for Cedar County, Iowa**

Iowa State University County Fiscal Impact Model		
County: C E D A R	FIPS: 19031	150
Items	Total Im p a c t s	
In Commuters	27	
Out Commuters	(1)	
Labor Force	122	
Population	229	
Enrollment	37	
(Taxable Retail Sales)	1,900,096	
Fiscal Summary:		
Revenue Change	75,983	
Expenditure Change	70,111	
Other Taxes	1,972	
Federal Aid	1,218	
State Aid	15,750	
Local Aid	1,231	
General Charges	3,610	
Miscellaneous	9,857	
General Revenues	75,983	
Expenditures		
All Administration	5,097	
Police-Law	7,430	
Enforcement	2,259	
Highways	17,355	
Community Development		
Parks and	2,073	
Recreation	8,020	
Public Health	10,056	
All Other	17,821	
Direct Expenditure	70,111	
Education Property Taxes	56,757	
Education State Aid	89,451	
Total Education Receipts	157,409	
Total Education Spending	157,409	

After the I-O run is completed, in this case, we decide that 150 of the total job impacts will accrue to Cedar County. In doing so we stimulate a re-estimate of incommuting

and outcommuting, which in turn recalculates the labor force size, the expected growth in population, the expected change in enrollment for the county. We must emphasize that this is very useful information for counties, cities, and school districts: they are quite comfortable with translating human changes into general local service changes. In the model, the labor force and population changes lead to changes in the fiscal items for the county government under study.

Concomitant and compatible estimates are made for community impacts as well in the city in which the direct employment changes is taking place. Separate estimates are also made for incremental contributions to state sales, license, income, and corporate income taxes in our modeling system. The idea is to generate as much information as possible about a potential economic change so that county, city, school, and even state government planners can anticipate the policy impacts of the change. The estimates produced above are the expected marginal change in revenue capacities and marginal changes in demands for public services. They are not predictions – they are simulations based on how communities in Iowa behave as they grow or decline. These impacts also represent the sum of all anticipated changes barring all other changes that might be accruing in the community and the region. We generally apportion the labor force and fiscal effects over a three year period using an elemental formula of allocating 70 percent of the total effects the first year, 20 percent the second, and 10 percent the third.

Of the possible types of assessments, the scenario that we just described fits more properly in the “impact” mode than the trend forecast mode. However, we often help to project future changes by incorporating sets of growth scenarios into a community assessment. Our most likely kind of assessment involves a firm or two within a community that have a start-up scenario and expansion scenarios over a reasonable time period, say five years. In these instances we then produce multiple year estimates of labor and fiscal impacts to better assist the county or the community under study to understand when the majority of the impacts are going to accrue and the kind and amount of pressures that are going to be placed on local service demands. We find that these types of assessments are becoming more and more common as community economic development horizons broaden and their willingness to explore total economic, labor, and fiscal consequences increases.

### **Impact Analysis: Other Experiences**

To date we have worked directly with at least 10 states in assisting them in their efforts to develop fiscal and labor force impact models. Each state’s motivation and particular application is slightly different. Each state has a different set of structural incentives or inhibitions from investing and applying these models to their extension systems or as part of their university based services to local governments. Nonetheless, for those interested, there are very real issues to be addressed and many believe that adopting this type of modeling capacity will assist in their public service mission.

The original VIP model in Virginia and the Show Me model in Missouri are designed as part of a more integrated and longer-termed relationship with communities. These

models were constructed, perhaps first and foremost, for testing change scenarios over time and assessing the fiscal condition of the communities in which they were employed.

Model development in Wisconsin has centered around developing field staff capacity to assess change. A particular application is the burgeoning retirement industry in bucolic Wisconsin areas. Changes in commerce, commercial activities, and demands for specific goods and services can be attributed to changes in demographic composition and, accordingly, changes in regional labor supply.

Western states, like Nevada and Oregon have resource extraction and land management issues to address. They also have their unique issues as state and federal restrictions on logging and other extraction activities are worked out. Opportunities abound and flounder surrounding recreation, game management, and range management. Whole community structures change as single source industries wane. Because of the preponderance of federal land, each administration change rewrites the rules of local finance and the uses to which public lands can be put. Rural areas face, sometimes, catastrophic changes and little guidance as to the human and economic costs of those changes. Community planning models as described in this manual might assist in developing local and regional strategies for change.

### **Impact Analysis: New Directions**

As we look to the future, we see that linking I-O with a labor force change and fiscal models is simply not enough in today's complex society. Notwithstanding the ever-evolving state of fiscal federalism in the U.S., in Iowa, we have re-designed our model to assess sets of local government functions (education, roads, law-enforcement, parks and recreation, waste water and solid waste management, etc.) instead of local governments by type. We have also incorporated some of the elements of the Wisconsin effort: we have added several categories of commercial activity and commercial establishments to our model. To soon follow are additional variables on specific types of land use and land values.

We are investigating different social and environmental variables, too. Poverty and welfare reform give rise to dozens of questions about existing institutions, the economy, labor force mobility, and the overall well-being of families and children receiving public assistance. Community models might be instructive in first redefining the labor force identities (people leaving welfare are new labor force entrants) and helping to work through the mobility probabilities of those populations given different job opportunity scenarios.

In Iowa, we also have a very large, comparatively, elderly population. The needs of the elderly, the constraints that they place on population and job growth, and the overall development of services and institutions to accommodate their needs are important factors that must be assessed seriously by policy analysts.

Finally, as one of the nation's leading agricultural states, Iowa also must confront agriculture's externalities. From large hog facilities to soil erosion to ongoing water quality

issues associated with agricultural chemical applications and livestock feeding, the state faces a myriad of very real environmental issues. Water quality and land use are pressing issues that will not lessen in the near future. Added to these factors is the continued onslaught of technology which promises to propel more and more rural residents into urban areas. Community models like those developed in Iowa and other Midwestern areas will perhaps be instrumental in helping citizens and public leaders to accommodate those issues and inevitable changes.